

United States
Department of
Agriculture

Natural Resources
Conservation Service

Shoshone-Bannock
Tribes

Shoshone-Bannock
Natural Resources
Conservation District

United States
Environmental Protection
Agency

United States
Department of Interior –
Bureau of Indian Affairs

United States
Department of Interior –
Geological Survey

Fort Hall

Ground Water Quality

Cooperative River Basin Study

Fort Hall Indian Reservation

**Bingham, Bannock and Power
Counties, Idaho**

December 2006

PAGE LEFT INTENTIONALLY BLANK

FORT HALL
GROUND WATER QUALITY
RIVER BASIN STUDY

Bingham, Bannock and Power Counties, Idaho

Requested by:

**Shoshone-Bannock Tribes
Fort Hall Indian Reservation
and
Shoshone-Bannock
Natural Resources Conservation District**

Prepared by:

**USDA
Natural Resources Conservation Service**

In Consultation with:

**Shoshone-Bannock Tribes
Land Use Department**

Bureau of Indian Affairs

and

**United States
Environmental Protection Agency**

December 2006

PAGE LEFT INTENTIONALLY BLANK

TABLE OF CONTENTS

TABLE OF CONTENTS	I
SUMMARY	1
INTRODUCTION AND OBJECTIVES	3
PURPOSE, PROGRAM DESCRIPTION AND AUTHORITY	3
OBJECTIVES OF THE SPONSORS	3
SCOPE OF THE PROJECT	4
RECENT PROGRESS	4
PROJECT SETTING.....	5
LOCATION AND DESCRIPTION	5
HISTORY OF THE PROJECT AREA	6
<i>Pre-History and Earliest History.....</i>	<i>6</i>
<i>History of the Fort Hall Indian Reservation.....</i>	<i>6</i>
AGRICULTURAL HISTORY	6
LAND OWNERSHIP	7
LAND USE	7
CLIMATE	7
TOPOGRAPHY AND GEOMORPHOLOGY	8
HYDROGEOLOGY	9
POPULATION AND EMPLOYMENT (FORT HALL INDIAN RESERVATION, IDAHO).....	9
AGRICULTURAL ECONOMY	9
WILDLIFE.....	10
RESOURCE PROBLEMS.....	11
RESOURCE PROBLEM STATEMENT	11
WATER RESOURCE PROBLEMS IDENTIFIED	11
<i>Nitrates</i>	<i>11</i>
<i>Pesticides</i>	<i>11</i>
SOURCES OF POLLUTANTS TO GROUND WATER.....	11
<i>Nutrient and Irrigation Water Management.....</i>	<i>12</i>
AGRICULTURAL PRACTICES CONTRIBUTING TO POLLUTION	12
EFFECTS OF POLLUTION	12
GOAL AND OBJECTIVES.....	12
<i>Goal</i>	<i>12</i>
<i>Objectives</i>	<i>12</i>
RESOURCE INVENTORY	13
COMMON RESOURCE AREAS.....	13
CRA 11.3 <i>Snake River Plains – Upper Snake River Plain</i>	<i>13</i>
CRA 13.4 <i>Eastern Idaho Plateaus – Sagebrush Steppe and Woodland-Covered Hills and Low Mountains...13</i>	<i>13</i>
CRA 13.5 <i>Eastern Idaho Plateaus – High Elevation Forests and Shrublands.....</i>	<i>13</i>
CRA 13.6 <i>Eastern Idaho Plateaus – Sagebrush Steppe Valleys.....</i>	<i>13</i>

RESOURCE SETTING	14
<i>Sprinkler Irrigated Crop Land</i>	14
<i>Surface Irrigated Crop Land</i>	14
<i>Hayland</i>	14
<i>Pasture</i>	14
<i>Dry Crop Land</i>	15
<i>Rangeland</i>	15
<i>Nutrients Applied</i>	15
<i>Disposal of Agricultural Chemicals</i>	15
SOILS	15
<i>Soils Mapping From 1995</i>	16
IRRIGATION HISTORY	17
CURRENT IRRIGATION WATER USE – ZONE 1 COMPARISON	17
<i>Consumptive Use Requirements</i>	18
<i>Surface Irrigation</i>	18
<i>Sprinkler Irrigation</i>	19
EFFECTS OF DEEP PERCOLATION OF IRRIGATION WATER ON GROUND WATER QUALITY	20
SURFACE WATER QUALITY	22
<i>Water Quality Limited Water Bodies</i>	22
<i>Aquatic Biology and Habitat Concerns</i>	25
GROUND WATER QUALITY	27
<i>Ground Water Vulnerability and Contamination Sources</i>	27
<i>Ground Water Quality Summary</i>	33
<i>Summary and Implications</i>	42
IRRIGATION AND FERTILIZER RISK ASSESSMENT	43
<i>Agrichemical Use</i>	43
<i>Field Studies</i>	43
<i>Risk Assessment Model</i>	46
DRAINAGE SYSTEMS	47
CRITICAL AREAS	48
POTENTIAL ALTERNATIVE SOLUTIONS	49
INTRODUCTION	49
ALTERNATIVES CONSIDERED (ALTERNATIVES 2 – 5 ARE NOT MUTUALLY EXCLUSIVE).....	49
<i>Alternative 1 - No Action - Future Without Project</i>	49
<i>Alternative 2 – Land Treatment of All Critical Irrigated Crop Land Acres</i>	49
<i>Alternative 3 – Ground Water Quality Mitigation</i>	49
<i>Alternative 4 – Centralized Automated Irrigation Water Management</i>	50
<i>Alternative 5 – Expand the Zone 1 Soil Survey</i>	50
DISCUSSION AND EVALUATION OF ALTERNATIVES	50
CONCLUSIONS AND RECOMMENDATIONS	53
CONCLUSIONS	53
RECOMMENDATIONS	53
<i>High Level of Nutrient Management</i>	53
<i>High Level of Irrigation Water Management</i>	54
<i>Integrated Pest Management Strategies</i>	55
<i>Safe Handling and Disposal of Pesticides and Pesticide Containers</i>	57
<i>Continued Water Quality Monitoring</i>	59

POTENTIAL SOURCES OF FUNDING.....	61
CONVENTIONAL BANK LOANS	61
CONSERVATION OF PRIVATE GRAZING LAND (GLCI).....	61
ENVIRONMENTAL PROTECTION AGENCY (EPA) INDIAN GENERAL ASSISTANCE PROGRAM	61
EPA NON-POINT SOURCE POLLUTION PROGRAM (CWA 319).....	61
EPA WATER POLLUTION CONTROL PROGRAM (CWA 106).....	61
ENVIRONMENTAL QUALITY INCENTIVES PROGRAM.....	62
HABITAT IMPROVEMENT PROGRAM (HIP)	62
IDAHO DEPARTMENT OF WATER RESOURCES (IDWR)	62
NRCS ASSISTANCE TO CONSERVATION DISTRICTS - PUBLIC LAW 46	62
RESOURCE CONSERVATION AND DEVELOPMENT (RC&D)	62
US FISH AND WILDLIFE SERVICE (USFWS) PARTNERS PROGRAM.....	63
WATERSHED PROTECTION AND FLOOD PREVENTION ACT (PUBLIC LAW 83-566).....	63
WETLANDS RESERVE PROGRAM AND CONSERVATION RESERVE PROGRAM	63
WILDLIFE HABITAT INCENTIVES PROGRAM	63
REFERENCES	65
APPENDIX A. WATERSHED MAPS	69
Map 1. Land use and land cover with the project area.	71
Map 2. Soil drainage classes within the project area based on the 1977 soil survey.	73
Map 3. Soil hydraulic conductivity class within the project area based on the 1977soil survey.	75
Map 4. Depth to water with the project area based on the 1977 soil survey.	77
Map 5. Soil permeability ratings for Zone 1 soils based on the 1995 soil survey.	79
Map 6. Presence of gravel in soils within Zone 1 based on the 1995 soil survey.	81
Map 7. Depth to water table (including seasonal) within Zone 1 based on the 1995 soil survey.	83
Map 8. Nitrate levels in wells in the project area sampled during 2003-4.....	85
Map 9. Location of wells within the project area with recent pesticide detections.	87

PAGE LEFT INTENTIONALLY BLANK

SUMMARY

Sponsors: Shoshone-Bannock Tribes, Shoshone-Bannock Natural Resources Conservation District

Location: Fort Hall Shoshone-Bannock Reservation,
Bingham, Bannock and Power Counties, Idaho

Size: Approximately 85,000 acres of irrigated crop land within the Project Area, encompassing the Gibson Terrace and Michaud Flats areas

Sponsors' Objectives:

- Short Term: minimize known immediate health risks from exposure to ground water contaminants and to protect and enhance the quality and quantity of surface and ground water.
- Long Term: minimize health risks by protecting the ground water resource from further contamination and reducing all existing contaminants to 50 percent or less of the Federal Drinking Water Standards (FDWS) Maximum Contamination Level (MCL) or Health Advisory (HA) levels and maintain the sustainability and economic viability of the local farming community.

Affected Aquifers: Pacific Northwest Basin-Fill Aquifers (shallow alluvial aquifer)
Snake River Plain Aquifer, an EPA "Sole Source" aquifer

Major Partners: Shoshone-Bannock Tribes
Natural Resources Conservation Service
Bureau of Indian Affairs
United States Environmental Protection Agency
United States Department of Interior – Geological Survey

Major Agricultural Products: Wheat, barley, potatoes, sugar beets, alfalfa, pasture

Land Ownership: Of the entire 543,588 acres on the Reservation:

- 97.9% is tribally owned;
- 2.1% is non-Indian owned;
- About 1,500 non-Indians and 3,000 Tribal members live on the Reservation.

Resource Problems Identified:

- ☐ Declining ground water quality
- ☐ Impacted surface water quality
- ☐ Low soil health

Alternatives Considered:

- ❑ **Alternative 1** – No Action - Future Without Project
- ❑ **Alternative 2** – Land Treatment of All Critical Irrigated Crop land Acres
- ❑ **Alternative 3** – Ground Water Quality Mitigation Land Treatment
- ❑ **Alternative 4** – Centralized Automated Irrigation Water Management
- ❑ **Alternative 5** – Expand the Zone 1 Soil Survey

Recommendations:

- Recommend expanding the Zone 1 Soil Survey to include the entire project area or remapping of the entire crop land use area of the Fort Hall Indian Reservation.
- Recommend implementation of Alternative 2 - Land treatment of all critical irrigated crop land areas utilizing all available programs.
- Recommend that the Tribes revise or develop new agricultural leases on the Reservation which contain language that requires the lease holders to develop and maintain a conservation plan with the NRCS and the NRCD including:
 - 1) Nutrient Management Plan,
 - 2) Irrigation Water Management Plan,
 - 3) Pest Management Plan.
- Recommend that the Tribes consider changes to the current crop rotations to include a crop following potatoes based on its ability to utilize carryover nitrogen and to uptake nutrients from below the potato rooting depth. In addition it would be desirable that the rotational crop be a late nitrogen feeder to utilize the carryover nitrogen that is contained in the vines of the potato crop.
- Recommend that the lease holders utilize and are equipped with the latest Irrigation Water Management (IWM) technology including meters and moisture sensors.
- Recommend that the Tribes require lease holders to utilize the recommended nutrient and Integrated Pest Management (IPM) management strategies.
- Recommend that the Tribes continue with water quality monitoring.

Critical Areas:

Critical areas are areas or operations which contribute the most to nitrate contamination of the deep and shallow aquifer. The following were identified as critical areas in the project area which include Zones 1, 2 and 3 (based on the Farm Chemical Ground Water Management Plan, Shoshone-Bannock Tribes, see Figure 1):

Approximately 85,000 acres of irrigated crop land on 0 to 10 percent slopes, including rotations of row crops (such as potatoes) on sandy to loamy soils with moderate to rapid permeability, well to excessively drained soils and those soils that contain coarse gravelly material at 20 to 40 inches or have a high water table.

INTRODUCTION and OBJECTIVES

Purpose, Program Description and Authority

Cooperative River Basin studies provide USDA planning assistance to federal, state and local governments. Section 6 of Public Law 83-566 authorizes the Secretary of Agriculture to engage in the study of watersheds in cooperation with state and other federal agencies. The Natural Resources Conservation Service serves as the lead agency for the Secretary to engage in cooperative river basin investigations for the following purposes:

- to assist in evaluation of water and related land resources,
- to determine the nature and extent of the problems, and
- to formulate alternative plans, including land treatment, non-structural or structural measures or combinations that will solve existing problems or meet existing or projected needs.

Objectives of the Sponsors

Cooperative river basin studies concentrate on specific objectives identified by the requesting agencies and citizen groups. In this case, the Shoshone-Bannock Tribes of the Fort Hall Indian Reservation, and the Shoshone-Bannock Natural Resources Conservation District requested assistance from the Natural Resources Conservation Service to develop a course of action to protect the ground water resources in the Fort Hall vicinity. The objectives are to:

- Short Term: minimize known immediate health risks from exposure to ground water contaminants and to protect and enhance the quality and quantity of surface and ground water
- Long Term: minimize health risks by protecting the ground water resource from further contamination and reducing all existing contaminants to 50 percent or less of the Federal Drinking Water Standards (FDWS) Maximum Contamination Level (MCL) or Health Advisory (HA) levels and maintain the sustainability and economic viability of the local farming community.

The impetus for this Cooperative River Basin Study and for the Preliminary Investigation, completed in 1991, was monitoring data that showed ground water contaminants posed a health risk to domestic well water users. Nitrates and pesticides detected in some wells in the unconsolidated aquifer of the Gibson Terrace and the Zone 1 area are above the current acceptable health risk levels. The majority of residents on the Fort Hall Indian Reservation get their drinking water from ground water sources (either private wells or community water systems). The likely source contaminants of major concern are current and historic application and disposal of agricultural chemicals. Some existing wells may serve as transport mechanisms for contaminants.

According to Keith Tinno (Fort Hall Business Council Chairman), "...the same conditions that make Fort Hall ideal for growing potatoes also make the ground water extremely vulnerable to the impacts of agricultural chemicals. The soils and underlying materials are coarse with very high permeability rates. Quite simply, water moves rapidly through the soil, very little is held and any excess water will move readily below the root zone carrying agricultural chemicals on a

certain course towards the ground water. Although the agricultural production practices on the Reservation are good, because of the nature of the soils and geology, good is not good enough. We have to work together to make these practices better, in fact, the best. This is what makes this project unique and I am optimistic that it will be a model for other projects across the nation.” (*Opening address to Shoshone-Bannock Tribes Annual Farmers Certification Seminar, Feb. 1994*).

Scope of the Project

The project area has a variety of resource problems. However, the scope of the project is focused on ground water quality concerns on the Fort Hall Indian Reservation. The ground water concerns specifically addressed in this plan include nitrates and current-use pesticides. For that reason, only irrigated crop land is addressed in this study and only alternatives and recommendations that address these ground water quality concerns related to irrigated crop land in critical areas have been considered.

The relative contributions of all potential contaminants were addressed in the Preliminary Investigation, and recommendations were provided to address the non-agricultural sources (e.g., septic systems). These recommendations are still valid. This study specifically addresses agricultural contributions to ground water degradation.

Ground water on the Fort Hall Reservation has been severely impacted by ethylene dibromide (EDB), which was banned by EPA in 1984 due to the significant health risks. The Tribes have been working with EPA to address the health concerns and impacts of EDB. While this is still a significant concern, this plan addresses current-use pesticides, and nitrates. Additional efforts needed to address the EDB concern are outside the scope of NRCS programs.

Recent Progress

In the years since the Preliminary Investigation was completed, many activities have been completed that address existing ground water problems and opportunities for improvement. The soils in Zone 1 were remapped with a special focus on high water tables, available water capacity and other factors indicative of vulnerability to ground water contamination. A three-year multi-agency study of management practices to reduce ground water nitrates was conducted on about 2,500 acres of crop land on the Gibson Terrace using the Water Quality Incentive Program (WQIP). This project showed that farmers could successfully grow potatoes and wheat within the upper limits set for nitrogen fertilizer and irrigation water. Ground water quality monitoring by the Tribes has continued. A new domestic well construction standard was adopted for the Reservation following a condition assessment of existing wells. The discovery that many wells were installed using perforated pipe that permitted water from different zones to mix presented a contamination risk to the individual household and the unconsolidated aquifer. Many domestic and irrigation wells with aquifer isolation problems have been sealed and replaced using an EPA 319 grant. Another 319 grant was obtained to study the potential risks of specific soil fumigants on ground water. A clean-up program for agricultural chemical containers was instituted by the Tribes. The Shoshone-Bannock Tribes are currently updating the existing Farm Chemical Ground Water Management Plan in cooperation with EPA.

PROJECT SETTING

Location and Description

The Fort Hall Indian Reservation covers 543,588 acres in southeastern Idaho. The Reservation and Bureau of Indian Affairs (BIA) Headquarters are located at the Fort Hall town site about 12 miles north of Pocatello, Idaho. Fort Hall is located west of Interstate 15 approximately midway between Pocatello and Blackfoot, Idaho.

In the late 1980s the Tribes divided the Reservation into three zones based on water quality, land use and ground water vulnerability. The project area (Figure 1) includes the area identified by the Tribes as Zone 1 (the Gibson Bench area) and most of the irrigated crop land in Zone 2 and 3. The NRCS (SCS) Preliminary Investigation Report concentrated on Zone 1. Zone 1 covers an area of about 27 square miles (approximately 17,280 acres), located just to the north and west of the Fort Hall town site. The River Basin Study addresses the ground water problems within the irrigated crop land areas which collectively include Zones 1, 2 and 3.



Figure 1. Location of the project area. Zones 1, 2, and 3 refer to the delineations outlined in the Preliminary Investigation, and were taken from the Fort Hall Reservation Farm Chemical Ground Water Management Plan. Zone 2 includes the area outside Zone 1, and east of the Portneuf River.

History of the Project Area

Pre-History and Earliest History

During the years before European contact, the Shoshone-speaking Indians inhabited most of what is now Idaho. During the 18th century, Northern Paiute Indians (now called Bannocks) migrated into southern Idaho from eastern Oregon. Both Tribes descend from the Numic family of the Uto-Aztecan linguistic phylum. The Tribes generally subsisted as hunters and gatherers, traveling during the spring and summer seasons, collecting foods for use during the winter months. They hunted wild game, fished the region's abundant and bountiful streams and rivers (primarily for salmon), and collected native plants and roots. Buffalo served as the most significant source of food and raw material for the Tribes. After the introduction of horses during the 1700s, hundreds of Idaho Indians of various tribal affiliations would ride into Montana on cooperative buffalo hunts. The last great hunt of this type occurred in 1864, signaling the end of a traditional way of life.

History of the Fort Hall Indian Reservation

A 1.8 million-acre Fort Hall Indian Reservation was established by Executive Order under the terms of the Fort Bridger Treaty of 1868. A survey error reduced the Reservation to 1.2 million acres. The name "Fort Hall" comes from a trading post built on the traditional Shoshone-Bannock wintering grounds near the Snake River in the early 1800s. The Bannock War of 1878 marked a major attempt of native hunters to fight for their traditional way of life. In 1883, the Fort Hall military post closed permanently.

In 1887, the General Allotment Act (Dawes) allotted 160 acres to each head of household and 40 acres to each minor. This bill opened surplus Reservation lands to white settlers, despite Indian protests. Soon after that, 418,560 acres of the Reservation were sold for \$1.25 an acre (above considerable Indian protest) through a series of agreements between the Tribes and the federal government. The area included Lava Hot Springs and what is now the city of Pocatello. In 1891, the Dawes Act was amended to provide 80 acres of agricultural land and 160 acres of grazing land to each Indian. By the turn of the century, the city had grown so dramatically that the Tribes were forced to agree to the cession of about 420,000 acres to accommodate it. Their compensation was approximately \$600,000. On June 17, 1902, six thousand settlers took part in the "Day of the Run" land rush. By the year 1914, over 347,000 acres had been distributed among 1,863 individual allotments. By the time this process was completed, nearly 36,000 acres had been alienated from Indian ownership through sales, patents in fee, or certificates of competency. The 1934 Indian Reorganization Act stepped in to remedy the excesses of allotment. By 1992, 96 percent of the Fort Hall Indian Reservation was once again under Indian control, either through federal trust or ownership by individual tribal members.

Agricultural History

Much of the area with sandy soils located north and west of Fort Hall (Zone 1, or the Gibson Terrace area) was rangeland until the early 1960s. At that time, non-Tribal members began leasing this area and converting it to irrigated crop land, used mainly for potato production. The sandy soils provided an excellent medium for growing high quality potatoes. However, inputs of water, nutrients and pesticides were high. This conversion continued until 1987 when most of the available land was in crop production.

The first indication of the presence of ground water contaminants in the area resulted from US Geological Survey (USGS) monitoring in 1988. Subsequent monitoring by USGS in 1989 and 1990 showed that several areas in the Fort Hall vicinity had elevated levels of nitrates in the ground water.

Land Ownership

The project area has an intermixed ownership pattern with about 30 percent individually deeded lands and 70 percent tribal owned land. Much of the farmland is leased to large farming operations controlled by non-tribal members. There are 23 operators who lease large areas of tribal lands. All farms in the project area are minority farms because 100% of leased lands are owned by tribal members.

Of the entire 543,588 acres on the Reservation:

- 97.9% is tribally owned;
 - 2.1% is non-Indian owned;
 - About 1,500 non-Indians and 3,000 Tribal members live on the Reservation.
- (Source: Shoshone-Bannock Land Use Office)*

Land Use

Land use in the project area is comprised mainly of sprinkler and surface irrigated crop land, hayland and pasture, as well as dry pasture and rangeland. There are about 110,000 acres of irrigated crop land and 40,000 acres of dryland wheat farms within the boundaries of the Fort Hall Indian Reservation. In the project area, there are approximately 85,000 acres of irrigated crop land. The majority of the crop land is located near and along the Gibson Terrace including 30,000 acres of crop land, located north and west of the townsite of Fort Hall (Land Use Map, Appendix A). Each year, about 12,000 to 15,000 acres are devoted to potato production. Much of the crop land is highly erodible due to wind because of the sandy surface textures. Farming practices needed for wind erosion protection are carefully regulated by the Tribal Council and BIA.

Climate

The project area has a semi-arid climate with cold winters and warm dry summers and receives only 9 to 11 inches of precipitation annually. Most crops grown must receive supplemental water from irrigation. Snow is the dominant form of precipitation in winter; but the wettest and windiest months occur in the spring. Freezing temperatures are common through most of April and the first freezing temperatures typically occur in mid-September (Figure 2).

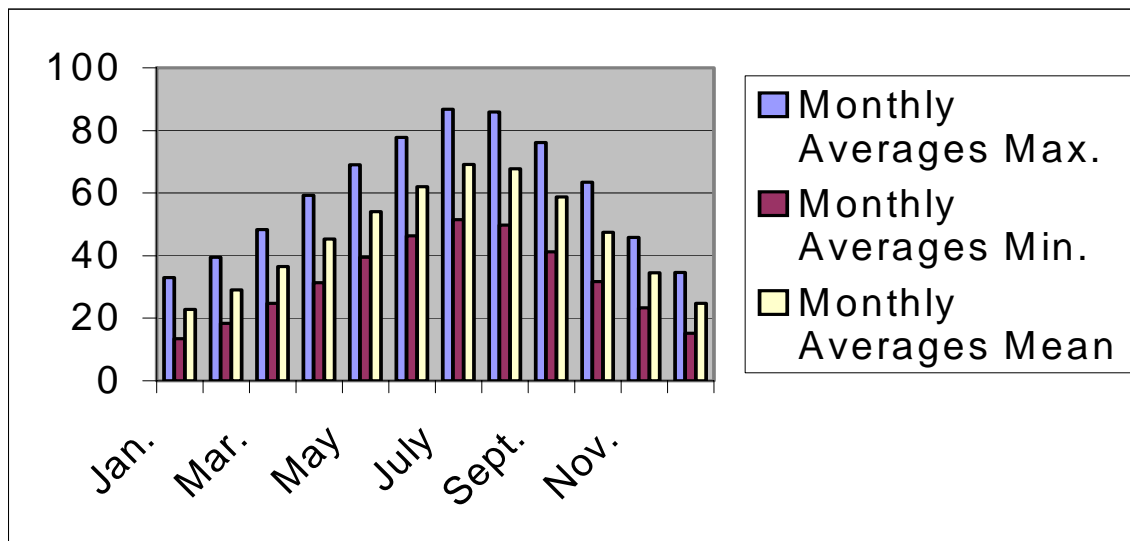


Figure 2. Fort Hall average monthly temperatures, in degrees Fahrenheit.

Topography and Geomorphology

The major topographic feature of the project area is the gently undulating Gibson Terrace of the Snake River, where most slopes are less than 2 percent. There are areas of sand dunes scattered over the Gibson Terrace and on the fan terraces at the eastern edge of the project area. The floodplains known as the "Fort Hall bottomlands" lie along the western edge of the project area. This area is nearly level except for the narrow steep slope breaks which parallel the three streams of the bottomlands: the Snake River, Spring Creek, and Clear Creek. The Snake River and its tributary, the Blackfoot River, define the western and northern boundaries of the project area. Elevations range from 4,370 feet along Clear Creek on the west side to 4,520 feet along the Fort Hall Canal on the east side.

The Fort Hall Indian Reservation straddles the border between the Basin and Range Geomorphic Province on the south and east and the Eastern Snake River Plain Geomorphic Province to the west and north. The Rocky Mountain thrust belt lies to the north. The project area is mainly within the Snake River Plain. Bedrock in the project area is Tertiary Age basalt which slopes westward generally between 100 and 300 feet below the surface (Dow 1978). Deep beneath the Snake River Plain basalts lay the Snake River Plain rhyolites from the ancestral Yellowstone Plateau.

Above the basalt are unconsolidated alluvial, lacustrine (lakebed) and wind-blown deposits of clay, sand and gravel. These materials are inter-bedded throughout the project area. Cinder cones and ash deposits also occur within the unconsolidated materials. The lakebed deposits generally consist of clay lenses within the sand and gravel. Most soils developed in either windblown sand and/or silt or in thin layer of eolian material over alluvial sand and gravel. Many soils in the project area are "bisequel" in this fashion, with topsoils developed in loess or sand and subsoils developed alluvial deposits. The surficial deposits occupy a relatively flat to slightly rolling basin-like river terrace with remnant dune influence (Mansfield 1920).

Some of the alluvial deposits in the project area date back to the Lake Bonneville flood, which catastrophically swept across Southern Idaho about 14,500 years ago, near the end of Pleistocene times. For perhaps eight weeks, the Snake River flowed at 500 times normal peak flows. Large tracts of sand and gravel were deposited far from the normal Snake River channel. As the flood receded, it left behind vast, nearly level slackwater deposits of silt, clay and very fine sand.

Hydrogeology

The relatively flat surface topography and sandy soils result in very little or no surface runoff in the project area. The regional Snake River aquifer is associated with the basalt bedrock. Water movement in the basalt aquifer is generally horizontal through basalt interflow (rubble) zones with local vertical movement along joints and fractures (Garabedian 1986). A shallow aquifer exists in the unconsolidated materials overlying bedrock in the study area, with water levels generally within the upper 30 feet below ground surface. Recharge to the ground water is from irrigation water seepage, stream and canal leakage, tributary valley underflow and precipitation (Garabedian 1986).

The coarse composition of the surficial deposits results in extremely high permeability and high rates of vertical infiltration. The clay lenses within the unconsolidated deposits retard water percolating through the surficial materials, creating perched zones in the unconsolidated aquifer. The water level gradient in the unconsolidated aquifer is only about two feet per mile (Parlman and Young 1992), contributing to relatively long resident time within the aquifer. Horizontal velocity of water moving through the unconsolidated aquifer may be slow, allowing contaminants to "build up" over time, with a related long-term flushing process required. Ground water movement in both the unconsolidated and basalt aquifers is generally west and south toward the Snake River and American Falls Reservoir (Parlman and Young 1992). A portion of the project area lies within an Idaho Department of Water Resources Ground Water Management Area due to water quantity concerns.

Population and Employment (Fort Hall Indian Reservation, Idaho)

During the first half of the 20th century, the Tribes' main sources of income were agricultural and livestock activities. In 1947, a large phosphate mine was established on the Reservation by an outside contractor. This was a significant source of tribal income and employment on through the late 1980's, when the mine played out. By then, the Tribes had diversified into an economy based mainly on row crop agriculture and gambling. The gaming industry and associated shops create significant employment opportunities for tribal members. In 1991, the tribal government's annual operating budget was \$13 million. The major concerns of the Shoshone-Bannock continue to be the health, education, and the dignified employment of their people, as well as the vitality of their customs, language, and natural resources.

Agricultural Economy

There is a concern about the continuation of incomes from agricultural land leases because of weak potato markets and the arrival of early blight, a potato disease. In addition, there is a potential for conflict over the continuation of potato culture because it is a high agricultural chemical input crop as well as a high-profit crop (or at least, it has been in the past when commodity markets were higher). Nevertheless, income from irrigated farm leases is very important because it is the largest source of income to the Tribes, now that the Gay phosphate mine is closed.

Wildlife

Primary wildlife categories in the project area include birds, mammals, reptiles, amphibians and aquatic life. Birds inhabiting the affected environment primarily include water birds and edge species common to crop land and wetland cover types in the Snake River basin. Categories of birds identified for the affected environment include upland game birds, raptors (e.g., hawks, owls, eagles, falcons and vultures), songbirds (e.g., passerines) and water birds (e.g., ducks, geese and shorebirds).

RESOURCE PROBLEMS

Resource Problem Statement

Excessive nutrients and pesticides are entering the ground water and contributing to ground water degradation. The potential agricultural contaminant sources include application of agrichemicals to irrigated crop land, storage facilities and improper disposal of agrichemicals. On-farm agricultural water management is contributing to off-site transport of nutrients and pesticides.

Water Resource Problems Identified

Agrichemicals have been detected in the unconsolidated aquifer and in the deep regional aquifer in areas on the Fort Hall Indian Reservation. Recent monitoring indicates that a number of wells have nitrate and/or pesticides that exceed health risk levels.

Nitrates

Initial sampling by USGS in 1989 showed 40% of wells sampled in the Gibson Terrace area exceeded 5 mg/L of nitrates. Based on 2003-4 sampling, the mean nitrate level for wells sampled as part of the Statewide Monitoring Network was 12.3 mg/L in the Gibson Terrace area (shallow alluvial aquifer) with a maximum of 24 mg/L, 2.9 mg/L in the area between Fort Hall and Chubbuck, and less than 2 mg/L in the Michaud Flats area (Figure 10). A ground water management plan for the Fort Hall Nitrate Priority area is scheduled for completion in 2009 (IDEQ 2006).

Pesticides

The 1990 Statewide Monitoring Program data indicated that some Reservation wells with detections of 1,2 dichloropropane and ethylene dibromide (EDB) exceeded the Maximum Contaminant Levels (MCLs) (5 ug/L and 0.05 ug/L, respectively). Continued monitoring identified an area approximately 63 square miles in size where ground water was contaminated with EDB (USDHHS 2005). As of 1996, 109 wells on the Reservation had detectable levels of EDB ranging from 0.02 to 15 ppb (MCL is 0.05 ppb) (IDHW 2002). Monitoring by IDEQ in 1993 also discovered elevated EDB levels in a community well off the Reservation (USDHHS 2005). Fifty two wells were sampled in 2004 in an area northwest of Chubbuck to just west of the Portneuf River (off-Reservation), with 20 detections of EDB.

Pesticides most recently detected in the Statewide Monitoring Network wells include atrazine, atrazine desethyl (breakdown product of atrazine), alachlor, metolachlor, metribuzin, EPTC, tebuthiuron, permethrins, and simazine (Figure 11).

Sources of Pollutants to Ground Water

Many of the pollutants contributing to the water quality problems in the project area originate from non-point agricultural sources. These are primarily from irrigated crop land. Additional sources of non-point and point source pollution includes improperly sited or improperly maintained septic systems and poor well construction. The aquifer is impacted by nitrates and pesticides from several agricultural sources.

Nutrient and Irrigation Water Management

The presence of available nutrients and pesticides in the soil profile is a major contributor to nutrients and pesticides entering ground waters. In the project area, nitrogen and pesticides present environmental risks. The risks are associated with nutrients being present in excess of crop uptake, lack of integrated pest management and over-reliance on pesticides, and irrigation water as an off-site transport mechanism. The combination of complex hydrogeology, highly permeable soils, shallow water tables, intensive cropping and high fertilizer and pesticide inputs has resulted in considerable environmental risk.

The use of conservation practices which minimize leaching will reduce the risk of off-site ground water quality impacts. Nutrient and pest management and irrigation water management (IWM) become the primary focus of optimizing nutrient applications, while maintaining adequate moisture for crop production.

Agricultural Practices Contributing to Pollution

- Inadequate irrigation water, pest and nutrient management
- Inefficient irrigation systems
- Cropping sequences

Effects of Pollution

- Deterioration of ground water quality impacting domestic wells
- Risk to human health from ground water and surface water contaminants

Goal and Objectives

The Shoshone-Bannock Tribes and the Shoshone-Bannock Natural Resources Conservation District have established the following goal and objectives for the Fort Hall Indian Reservation Ground Water Quality Project.

Goal

To protect and improve the quality of ground water resources on the Fort Hall Indian Reservation and the Snake Plain Aquifer, an EPA Sole Source Aquifer.

Objectives

- To improve and further protect the quality and quantity of ground water within the project area
- To identify the major non-point pollution sources in the area, as well as their origin
- To determine the water quality effects on the project area from implementation of planned conservation measures
- To develop a program to accelerate the transfer of knowledge and technology to the agricultural producers within the project area
- To develop a water quality program promoting voluntary cooperation in solving water quality problems

RESOURCE INVENTORY

Common Resource Areas

The Common Resource Areas (CRAs) described below are for the project area which are located in the American Falls HUC (17040206). A CRA is defined as a geographical area where resource concerns, problems, or treatment needs are similar. It is considered a subdivision of an existing Major Land Resource Area (MLRA) map delineation or polygon. Landscape conditions, soil, climate, human considerations, and other natural resource information are used to determine the geographic boundaries of a Common Resource Area.

CRA 11.3 Snake River Plains – Upper Snake River Plain

This nearly level unit is characterized by crop land, pastureland, cities, suburbs, and industries. Extensive surface and sprinkler irrigated small grain, sugar beets, potatoes, and alfalfa farming occurs. Frost-free season is shorter and crop variety is less than downstream CRA units. Aquatic resources have been degraded by irrigation diversions, channelization, dams, sewage treatment, nonpoint pollution, food processing and phosphate processing.

CRA 13.4 Eastern Idaho Plateaus – Sagebrush Steppe and Woodland-Covered Hills and Low Mountains

This unit occupies an elevational band between the higher mountains and the lower inter-montane valleys. Potential natural vegetation is mostly sagebrush steppe. Cool season grasses are more common than in the adjacent, drier units. Juniper woodland vegetative sites occur on shallow rock soils. Land use is primarily livestock grazing.

CRA 13.5 Eastern Idaho Plateaus – High Elevation Forests and Shrublands

This unit is mountainous and occupies the elevation band above Sagebrush Steppe Valleys and Woodland-Covered Hills and Low Mountains CRA units. It is characterized by a mix of conifers, mountain brush, and sagebrush grassland. North-facing slopes and many flatter areas support open stands of Douglas-fir, aspen and lodgepole pine. Winters are colder and the mean annual precipitation is higher than in lower elevation units.

CRA 13.6 Eastern Idaho Plateaus – Sagebrush Steppe Valleys

This valley unit is flanked by hills and mountains. It is dominated by sagebrush grassland and lacks woodlands, open conifer forest, and the saltbush-greasewood vegetation. Perennial bunchgrasses are more abundant than in the Sagebrush Basins and Slopes in Utah. Valleys mostly drain to the Snake River and fish assemblages are unlike those of the internally-drained basins to the south (MLRA 28A). Grazing is the dominant land use but non-irrigated wheat and barley farming is much more common than in MLRA 28A. This unit is less suitable for crop land and has less available water than many parts of the Snake River Plain (MLRA 11).

Resource Setting

Sprinkler Irrigated Crop Land

These areas include conventionally tilled crop land on soils ranging from sands to loams. Wind erosion is typically a problem from March to June, creating air quality and visibility hazards. Various combinations of small grains, alfalfa, potatoes, sugar beets and barley are grown. Some rotations contain less than 50% high residue crops. Nutrient and pest management may be less than desirable as well as irrigation water management and maintenance of sprinkler systems. Impacted surface and/or ground water quality is common. Wildlife habitat is often inadequate with limited permanent cover.

Surface Irrigated Crop Land

Conventionally tilled, often intensively cultivated crop land on 0-7% slopes. Precipitation is 12 inches or less. Soils are typically sandy loams, silt loams, and loams, and may have been extensively land-leveled in the past. Most surface irrigation is by siphon tube or gated pipe, but there is also some border irrigation. A variety of crops are grown in many combinations, with small grains and/or alfalfa as the most common. Wind erosion may be a problem following low residue row crops. Nutrient, pest, and/or irrigation water management may be less than desirable. Impacted surface and/or ground water quality is common.

Hayland

Conventionally tilled, surface and sprinkler irrigated on 0-7% slopes. Irrigation water is normally plentiful. Small grains and alfalfa are grown in rotation, with alfalfa typically maintained for 4-6 years. Grazing of crop aftermath is common. Nutrient, pest or irrigation water management may be less than desirable. Impacted surface and/or ground water quality is common.

Pasture

Some improved dryland pasture with introduced forage species including wheatgrasses, fescues, bromes, and orchardgrass and older established stands of low vigor, with encroachment of noxious weeds. Continuous season-long grazing is typical. No commercial fertilizers are applied, and pest management practices are limited. Livestock water may be inadequate.

Within the project area there are approximately 2,300 acres of permanent pasture and hayland. They are derived from very wet pasture soils and about 700 acres of *Shoban* soils. Most of the permanent pasture and hayland is sub-irrigated wet meadow near streams.

Irrigated pastures are often surface irrigated on variable soils with slopes 1-5%. Irrigation water distributed via earthen ditches, with tailwater eventually returning to rivers or streams. Fields may have been leveled. Irrigation efficiency is 20-35%. Plants are introduced forage species and native perennials, conventionally tilled when rotating pasture (10 years) and grain (2 years). Fertilizers are sometimes applied, but without soil testing or nutrient management. Adjacent riparian areas are important for wildlife.

Dry Crop Land

Primarily winter wheat/fallow (precipitation 10-14 inches) or annual spring barley (precipitation 16-22 inches), on silt loams with slopes 0-15% often characterized by significant ephemeral and concentrated flow erosion. Conventional tillage results in <15% residue after planting. Application of nutrients and pesticides typically does not meet Idaho NRCS standards. Some dry land crop acres have been converted for wildlife use through the Conservation Reserve Program.

Rangeland

Low elevation desert to high elevation, steep rangeland. Low elevation desert characterized by sagebrush and perennial bunchgrasses. Frequent fires have eliminated some areas of sagebrush, with annual cheatgrass and other invaders dominant. Carrying capacity can be limited by available water. Land is utilized by antelope, deer, elk, moose and livestock in winter and early spring. Mid-elevation rangeland has precipitation ranging from 12-16 inches with sagebrush and perennial bunchgrasses on variable soils on nearly level flats to benches and rolling hills. High elevation range has precipitation greater than 16 inches, on steep slopes and high mountain valleys. Access to riparian areas on all rangeland types is not typically managed, and temperature, nutrients, and sediment may be an associated water quality concern.

Nutrients Applied

Potatoes are rotated every other year with small grains. This crop requires a substantial amount of nitrogen and pesticides in order to produce maximum yields. When applied in excess, agricultural chemicals can readily be leached through sandy soil profiles and can contaminate the ground water. Additionally, potential contamination could result from improper chemigation and chemical mixing, loading and spillage near wells. The relative contribution for ground water contamination from these sources is estimated to be high.

Nitrates ($\text{NO}_3\text{-N}$) are considered to be the most widespread contaminant of concern in the project area. Excess ground water nitrates indicate the potential for other agricultural chemicals, especially water-soluble chemicals, to also occur. Nitrate is often found in ground water as a contaminant because of its high solubility in water (primary transport mechanism) and its numerous sources. The major source of ground water $\text{NO}_3\text{-N}$ in the project area is considered to be inorganic fertilizers.

Disposal of Agricultural Chemicals

Since the SCS/NRCS Preliminary Investigation in 1991, a clean-up program for agricultural chemical containers was instituted by the Tribes. The Shoshone-Bannock Tribes are currently updating the existing Farm Chemical Ground Water Management Plan in cooperation with EPA. In addition, the Idaho Department of Agriculture started an agricultural chemical disposal program. Excess chemicals can now be turned in for safe disposal every year.

Soils

The Fort Hall Soil Survey was completed in 1963 and published in 1977 (USDA-SCS 1977). In several ways, the Fort Hall Soil Survey is inadequate for the ground water vulnerability determinations that are now needed. The Gibson Terrace area was primarily rangeland when originally mapped as a Tindahay loamy coarse sand and sandy loam to a depth of 60 inches.

Now, it is intensively-managed irrigated crop land. Later soils mapping determined that many of the soils have coarse gravelly material 20 to 40 inches beneath the surface. Gravelly subsoils greatly increase vulnerability to ground water pollution; however, they were largely ignored in the old survey. In 1995, a new unpublished soil survey was developed covering 20,320 acres of the Zone 1 survey area.

Most soils in the project area developed in alluvium and/or eolian material from alluvium. Most have low water holding capacities. Wet soils are common on the Fort Hall bottomlands and in the southwestern part of the study area. There are about 3,000 acres of wet soils, of which nearly 400 acres are peat soils (Histosols). In the 1995 Zone 1 survey area, soil depths are almost universally very deep (greater than five feet) except for about 100 acres of Rojo Variant soils, which are moderately deep to duripan and to basalt bedrock. In wet soils, a seasonally high water table restricts the roots of non-hydrophitic (high water table intolerant) plants.

Soils Mapping From 1995

The following soils descriptions are from the Zone 1 area that was remapped in 1995.

Dry Soils on Stream Terraces, Escarpments and Fan Terraces

Dune Sands on Stream Terraces and Fan Terraces:

Quincy – Presto Variant Complex, on 0 to 6 percent slopes consists of very deep light-colored sands and loamy sands on stream terraces, escarpments and fan terraces. These soils are excessively drained with rapid permeability.

Panioque Variant, on 0 to 5 percent slopes consist of very deep well drained dark-colored loam and silt loam soils over extremely gravelly fine sand and loamy fine sand on stream terraces, escarpments and fan terraces. These soils have moderate permeability above 30 inches and rapid permeability below 30 inches.

Kukvey – Sheepskin – Magallon Variant Complex, on 0 to 3 percent slopes consist of very deep somewhat excessively drained dark-colored loamy sand and sandy loam soils over sand and extremely gravelly fine sand and very gravelly sand on stream Terraces, escarpments and fan terraces. These soils have very rapid to moderately rapid permeability.

Wet Soils on Bottomlands and Stream Terraces:

Silt Loams and Sandy Loams on Bottomlands and Stream Terraces:

Snake - Philbon– Aquolls, 0 to 2% slopes. Other soils include: *Shoban - Peteetneet Variant* muck, clayey subsoil - *Parehat* silt loam (high water table). Also present are a high water table phase and a saline-alkali phase of the *Snake* silt loam soil.

Soils in this unit are wet, dark and very deep. Drainage is poor or very poor in the major soils of this unit. A high water table is apparent between 0 to 36 inches at least from spring until mid-summer and all year in the major soils in this unit. Flooding frequency ranges from frequent to rare. *Philbon* peat is ponded most of the year. The potential rooting depth is over 60 inches for all soils in this unit, but only for water-tolerant plants because of the high water table.

There are 1,314 acres of this general soil map unit. Soils in this unit are mainly used for wet meadow pastures and wildlife habitat.

Shoban – Parehat Complex , 0 to 2% slopes at 4,380 to 4,450 feet elevation.

Soils in this general soil map unit are very deep and somewhat poorly drained. A high water table is apparent between 24 to 40 inches from May through November. These soils have a mixed sandy alluvium parent material, with very rapid permeability and account for 1,617 acres.

The major land uses are: irrigated crop land and pasture, wet meadow pastures and wildlife habitat. Crop yields are limited by a seasonal high water table. Management of agricultural chemicals requires a high level of management.

Irrigation History

Prior to 1960, there was little irrigation of the sandy soils of this area. Although up to 4.5 acre-feet per acre per year were allocated annually, it was only in the peripheral zones (on soils with slightly higher water holding capacities) where irrigation was practiced.

During the 1960s, irrigated acreage in the region expanded rapidly. This area, with its sandy soils, became a natural for development under sprinkler irrigation. The first sprinkler systems were solid sets and handlines. Handlines were especially labor intensive because the sandy soils required short irrigation intervals. The first center pivot systems appeared in the area around 1965, in order to offset labor costs. Early pivot systems were well designed for irrigation of sandy soils.

In the 1970s, both side roll and pivot systems became common. Efficiencies improved, but traditional irrigation systems continued to be labor intensive with short irrigation intervals.

By the early 1980s, there was almost a complete transition to center pivot systems, improving the level of irrigation water application. Since then, irrigation water management has also improved, as significant tracts of land are monitored for soil moisture to aid in irrigation scheduling to satisfy crop consumptive use requirements. Many land users hire consultants to provide irrigation scheduling information in order to minimize their irrigation pumping requirements. Improved irrigation water management is reducing the amount of deep percolation from irrigation. Surface runoff from sprinkler systems is almost non-existent on sandy soils.

Current Irrigation Water Use – Zone 1 Comparison

Zone 1 was selected to study the comparison between irrigation systems and irrigation water management. There is a total of approximately 20,600 acres of irrigated crop land within the Zone 1 area. Sprinkler systems account for approximately 18,350 acres and include handlines, side rolls and center pivots. The remaining area of approximately 2,300 acres is flood irrigated in border systems. Fields with border systems range in size from 1 to 40 acres. Sprinklers irrigate potatoes and grain, while the flood-irrigated areas support alfalfa hay and grass pastures. There are eight major soil types in the area and over 80 percent of the soils are sandy-textured and very permeable. Soil intake families vary from 0.2 to 3.0. Three canals

deliver water to this area: the Gibson Canal, North Canal and Fort Hall Main Canal. Deep wells irrigate approximately 8,830 acres.

The purpose of this phase of the study is to assess the potential ground water impact of irrigation water use, specifically, amount of deep percolation in the Zone 1 area.

Consumptive Use Requirements

Crop consumptive-use (CU) requirements for this area were computed by the Natural Resource Conservation Service (NRCS), using the modified Blaney-Criddle method. The primary inputs for this method are mean monthly temperatures and rainfall and monthly percent daylight hours. Temperature and daylight factors are multiplied by a crop specific stage of growth factor to yield estimated monthly consumptive-use. Effective precipitation may be subtracted from consumptive-use to yield net irrigation requirement (NIR).

The following table displays the distribution of the consumptive-use of the four prevalent crops in the area using the Blaney-Criddle method. A new Agrimet station has since been installed on the Reservation to accurately measure evapotranspiration (ET), CU and other weather parameters.

Table 1. Monthly and seasonal crop consumptive use (in inches).

	April	May	June	July	Aug.	Sept.	Oct.	Total
Alfalfa	1.77	4.02	5.62	7.87	6.34	3.66	1.71	30.99
Grain	1.15	3.86	6.17	4.52	0.13	----	----	15.83
Potatoes	1.56	3.35	4.59	6.48	5.44	3.24	1.41	26.07
Pasture	----	0.74	2.91	7.69	8.01	3.74	----	23.09

To estimate the seasonal volume of water delivered or pumped to the farms, a "backdoor" approach was used. Normal consumptive-use divided by the various application efficiencies approximates the total water delivered to the farms.

Surface Irrigation

Where surface irrigation is by flooded borders, the major crops are alfalfa hay and grass pasture. Potential irrigation efficiencies vary by soil type from 50 to 70 percent, with actual seasonal application efficiencies of an estimated 80 percent of potential. On loam and silt loam soils, deep percolation rates are lower than on sandier soils. Other water losses are runoff and minor evaporation. Typical estimated water losses on common local soil types are shown in Table 2.

Table 2. Percent runoff and deep percolation by soil texture.

Soil textures	Surface Runoff	Deep Percolation
Silt loam	75%	25%
Loam	50%	50%
Sandy	25%	75%

Water supply is sufficient for surface irrigated crops within this area. Therefore, crop consumptive-use divided by reasonable irrigation efficiencies should yield runoff and deep percolation data (Table 3). Such an analysis yields 2,536 acre-feet of runoff and 3,094 acre-feet of deep percolation under surface irrigation annually. Natural rainfall may add to the runoff and deep percolation potential, too. Mean annual rainfall within the area is about 12 inches.

Water application efficiencies can be improved. However, insufficient economic data introduces risk to net farm returns if a management shift to improve efficiencies should occur. Careful documentation and analysis would need to be done. Without changing method of irrigation, perhaps a 25 percent improvement could be made over present water loss. Pump-back systems could significantly reduce runoff, but, unless managed well, could also add to deep percolation. A full shift to sprinkler irrigation would significantly decrease runoff and deep percolation.

Table 3. Border irrigation parameters by soil type (from the NRCS National Engineering Handbook Section 15, Chapter 4, Borders, page 4-33, Table 4-12.

	Silt Loam	Loam	Sandy Loam	Loamy Coarse Sand	Loamy Sand	Sand	Total
Potential Efficiency (%)	50	50	55	65	70	65	
Actual Efficiency (%)	40	40	44	52	56	52	
Loss (%)	60	60	56	48	44	48	
Runoff (%)	45	30	14	12	11	12	
Deep Percolation (%)	15	30	42	36	33	36	
No. Acres	556.4	153.2	63.0	385.3	1050.0	45.1	2,253
Delivered to Field (Acre/Feet)	3307	911	340	1,762	4,458	206	10,984
Weighted C.U. (in.)	28.53	28.53	28.53	28.53	28.53	28.53	28.53
Runoff (acre-feet)	1,488	272	48	212	491	25	2,536
Deep Percolation (acre-feet)	496	272	143	635	1,473	75	3,094

Sprinkler Irrigation

Handlines, side rolls and center pivots irrigate 18,350 acres of potatoes and grain in the Zone 1 area. Center pivots alone account for 13,432 acres. The majority of soil within this area is light in texture and well suited to sprinkler irrigation. Little runoff takes place as a percentage of total water applied. Runoff rarely leaves the field and it is not in a large enough volume to re-use by a pump-back system. Application efficiencies are about 65 percent for handlines and side rolls and 75 percent for center pivots. Sprinkler efficiencies are independent of soil type.

Some soil moisture monitoring is practiced as an aid to improving irrigation scheduling. Consulting services in the area provide guidance to some growers when to irrigate. Those pumping from wells generally irrigate on demand to meet crop needs by some arbitrary or scientifically based method. Economic factors and physical resources could be enhanced by a more widely used soil moisture monitoring and irrigation-scheduling program.

Table 4 compares the potential water use and distribution under various methods of sprinkler irrigation for potatoes and grain.

Table 4. Sprinkler irrigation data.

	Hand-lines & Center Side-roll	Pivot	Total
Weighted C.U. (in.)	19.46	19.46	19.46
No. Acres	4,918	13,432	18,350
Efficiency (%)	65	75	----
Applied (Ac-Ft)	12,270	29,043	41,313
Runoff (Ac-Ft)	245	581	826
Deep Perc. (Ac-Ft)*	982	2,323	3,305

* Does not include deep percolation due to natural rainfall. Mean annual rainfall is about 12 inches.

The ground water impact of irrigation water is based upon estimates of application methods and soil intake characteristics. The quantitative field verification has not been done within the area to support the estimates. However, the "ballpark" figures shown in this report are to be taken as reasonable for the reported conditions of the area.

Eleven percent of the area is presently under surface irrigation and 89 percent is sprinkled. Future conditions could change to: (Future #1) a 50 percent improvement of present conditions; (2) a shift to all sprinkler with existing management; and, (3) a shift to all center pivot with high management.

Table 5 compares three potential changes to deep percolation based on changing the irrigation systems and/or a higher level of irrigation water management.

Effects of Deep Percolation of Irrigation Water on Ground Water Quality

Ground water quality is impacted by deep percolation from application of irrigation water. It is also impacted by seepage from canals and laterals. The primary interest of this study was to assess the former impact, but the latter must also be addressed and quantified if possible. Total seepage into ground water from canals and laterals can be potentially as great or greater than deep percolation from irrigation application.

Table 5. Present and alternative futures for irrigation in Zone 1.

	Surface Irrigation	Sprinkler Irrigation	Total
Present Conditions			
Present (Acres)	2,253	18,350	20,603
Application (Acre/Feet)	10,984	41,313	52,297
Runoff (Acre/Feet)	2,536	826	3,362
Deep Perc. (Acre/Feet)	3,094	3,305	6,399
Future Scenario #1	Improved IWM		
Future – 1 (Acres)	2,253	18,350	20,603
Application (Acre/Feet)	9,763	41,313	51,076
Runoff (Acre/Feet)	1,998	413	2,411
Deep Perc. (Acre/Feet)	2,404	1,652	4,056
Future Scenario #2	All Sprinkler Irrigated		
Future – 2 (Acres)	-----	20,603	20,603
Application (Acre/Feet)	-----	46,385	46,385
Runoff (Acre/Feet)	-----	927	927
Deep Perc. (Acre/Feet)	-----	3,711	3,711
Future Scenario #3	All Sprinkler with Improved IWM		
Future – 3 (Acres)	-----	20,603	20,603
Application (Acre/Feet)	-----	46,385	46,385
Runoff (Acre/Feet)	-----	464	464
Deep Perc. (Acre/Feet)	-----	1,855	1,855

Little published work exists in the area to support determination of canal and lateral seepage. Therefore, a method of estimating these losses needed to be developed. The Idaho Department of Water Resources (IDWR) published a book in 1971 titled "Water Users Handbook". Its most recent revision is dated 1978. Two methods of estimating seepage losses are presented in this publication - The Moritz Formula and a graphic method. The graphic method was used for this study.

Inputs to the graphic method require knowing canal carrying capacity and types of soil by texture through which the canal flows. Approximately three canals and 43 laterals transect 15 soil types. Total length of canals within the study area is 14.4 miles and for laterals estimated total length is 51.9 miles. Carrying capacity of the canals was pro-rated by length to the consumptive use and irrigation requirement of the area served. The Handbook graph was then used to estimate seepage loss per mile as percent of carrying capacity. It was assumed that carrying capacity of laterals averaged 15 cfs.

Silt loam soils accounted for 8.2 miles of the total length of canals with the remaining 6.2 miles through coarse grain material. For laterals, about 23.7 miles of silt loam soils is traversed with 28.2 miles through coarse grain soils.

Based on results using the graphic method (*IDWR Water Users Handbook*), canals lose at least 24 cfs to seepage within the study area and laterals lose about 48 cfs to seepage. Assuming a 120-day irrigation season, total seasonal seepage loss is estimated to be 17,100 acre-feet. This loss contributes to local perched water tables and to the deeper regional water tables and aquifer. It is estimated that deep percolation from irrigation application is 6,400 acre-feet per year. Deep percolation, along with canal and lateral seepage, results in an estimated total loss of 23,500 acre-feet per year within the area.

Surface Water Quality

Surface water quality problems are a resource concern in or adjacent to the project area. The Snake, Portneuf, and Blackfoot Rivers, American Falls Reservoir, and Bannock Creek (and associated tributaries of these water bodies) are impacted by a variety of pollutants (nutrients, sediment, temperature, and/or bacteria) and contribute to non-support of beneficial uses within the American Falls, Blackfoot, and Portneuf subbasins.

The Idaho Department of Environmental Quality (IDEQ) is the state agency primarily responsible for water quality in Idaho's rivers and lakes (off Reservation). As a requirement of the Clean Water Act, IDEQ must provide an accurate assessment of the state's waters. IDEQ works to implement federal and state water quality standards, including the regulation of pollutants that are discharged to the state's waters. The Shoshone-Bannock Tribes do not currently have primacy for administering water quality standards within the Reservation boundaries. Implementation of water quality standards on the Reservation are administered by the US Environmental Protection Agency (EPA).

Water Quality Limited Water Bodies

Section 303(d) of the Federal Clean Water Act requires states and tribes to list water bodies that are impacted by one or more pollutants. These water bodies cannot meet water quality standards for designated uses despite point source technologies. States must develop budgets for listed water bodies that determine the maximum loadings of pollutants of concern (incorporating seasonal variation and a margin of safety). Loads include both point and nonpoint sources contributing to the water body, and the maximum load must be consistent with water quality standards and designated uses. These budgets, or Total Maximum Daily Loads (TMDLs), must be approved by EPA and then become the basis for implementation plans to restore the water quality to a level that supports its designated uses. Designated uses for off-Reservation water bodies in the proximity of the project area are presented in Table 6.

Table 6. Designated (or existing) beneficial uses for water bodies adjacent to the Fort Hall Indian Reservation in southeastern Idaho (IDAPA 58.01.02).

River/Stream Segment or Water Body	Designated Beneficial Uses²
<i>American Falls Reservoir (and associated tributaries)</i>	Cold water aquatic life Primary contact recreation Domestic water supply
<i>Snake River, American Falls Reservoir to Ferry Butte</i>	Cold water aquatic life Salmonid spawning Primary contact recreation Domestic water supply
<i>Snake River, Ferry Butte to Bingham Co. line</i>	Cold water aquatic life Salmonid spawning Primary contact recreation Domestic water supply
<i>McTucker Creek, Headwaters to Snake River</i>	Undesignated ¹
<i>Bannock Creek, Headwaters to American Falls Reservoir</i>	Cold water aquatic life Salmonid spawning (existing use) Secondary contact recreation
<i>Moonshine Creek, Headwaters to Reservation Boundary</i>	Undesignated ¹
<i>Rattlesnake Creek, Headwaters to Reservation Boundary</i>	Undesignated ¹
<i>WF Bannock Creek, Headwaters to Reservation Boundary</i>	Undesignated ¹
<i>Knox Creek, Headwaters to Bannock Creek</i>	Undesignated ¹
<i>Portneuf River, Interstate 86 to Fort Hall Indian Reservation</i>	Cold water aquatic life Salmonid spawning Primary contact recreation
<i>Portneuf River, Headwaters to Chesterfield Reservoir</i>	Cold water aquatic life Salmonid spawning Primary contact recreation Domestic water supply
<i>Blackfoot River, Main canal to Wolverine Creek</i>	Cold water aquatic life Salmonid spawning Primary contact recreation
<i>Wolverine Creek, Headwater to Blackfoot River</i>	Cold water aquatic life Salmonid spawning Secondary contact recreation

¹ Undesignated water bodies are presumed to support cold-water biota and primary or secondary contact recreation unless IDEQ determines otherwise (IDAPA 58.01.02.140).

² All segments are designated for the statewide uses of agricultural and industrial water supply, wildlife habitat, and aesthetics.

For further information on Idaho water quality standards, policies and procedures please see <http://www2.state.id.us/adm/adminrules/rules/idapa58/0102.pdf>).

The most current approved listing of impacted Idaho water bodies is presented in the 2002 305b/303(d) *Integrated Report* (IDEQ 2006a). The report contains stream segments with designated uses that are deemed impaired by one or more pollutants or stressors. The 303(d) list provides a mechanism for the state to prioritize cleanup of water quality problems. Streams on the list are required to have a TMDL established within certain dates, or basin assessments demonstrating that beneficial uses are fully supported and therefore do not require TMDL development. Impacted rivers and streams adjacent to the project area are presented in Table 7

and Figure 3. The streams and rivers within the Reservation are currently identified as “Not Assessed” on the Idaho 2002 303(d) list because the state does not have the authority to designate uses within the Reservation.

The TMDL for American Falls (IDEQ 2004, IDEQ 2006b) was completed in June 2004 and then revised and resubmitted in 2006, but has not yet been approved by EPA. Beneficial uses within the subbasin have been impacted by irrigation diversions, channelization, grazing, dams, sewage treatment, nonpoint pollution, food processing, and phosphate processing (IDEQ 2004). The TMDL has identified several sources of pollutants. Agricultural land use and stormwater runoff have been positively related to both nutrient and sediment loading. Other likely contributors to sediment loading in subbasin streams are livestock practices; streambank erosion, and roads. Windblown sediment and shoreline erosion add to sediment loading in American Falls Reservoir. Wastewater treatment plants and waterfowl add to nutrient loading, primarily in the reservoir. Another source of phosphorus in the reservoir is bottom sediments, which add to overall phosphorus loading through internal recycling.

Other possible contributors of nutrients within the American Falls subbasin include livestock grazing, recreation, and failed septic systems. The target phosphorus levels selected to protect beneficial uses vary by water body, and range from 0.025 mg/L from ground water inputs to 0.05 mg/L for Portneuf River contributions. Only springs, tributaries, and drains to the American Falls Reservoir were assigned load targets. Based on the loading analyses, no reductions for nutrients or sediment are required for the Snake River. The Bannock Creek watershed had overall load reduction requirements of 30% for nitrogen and approximately 60% for phosphorus. Sediment reduction requirements differed by stream within the Bannock Creek watershed, and ranged from 0% to 56% reductions needs. A load reduction for nitrogen for McTucker Creek was approximately 25%, but no reductions are currently required for sediment or phosphorus.

The Blackfoot River Basin Subbasin Assessment and TMDL was approved by EPA in 2002. Current information suggests that some beneficial uses, such as cold water aquatic life and salmonid spawning, are impaired and are not fully supported in several streams in the subbasin. Sources of pollutant have been identified from various reports. Sediment input has been caused by agricultural and livestock practices, changes in the natural hydrograph, roads, mining activities, and mass wasting (IDEQ 2002b).

Agriculture, grazing, and recreation (human wastes linked to camping areas) have been associated with nutrient input into Blackfoot River subbasin streams. Results from IASCD sampling suggest sediment and nutrients increase during spring runoff, precipitation events, and downstream of the Reservation Canal (IASCD 2006). In 1996, the North Bingham and Central Bingham Soil and Water Conservation Districts signed a memorandum of understanding (MOU) with the Shoshone-Bannock Tribes and Blackfoot River Watershed Council (BRWC) to initiate recovery efforts in the watershed (IASCD 2006).

The sediment target for Blackfoot River subbasin was based on surrogates, utilizing both turbidity measures and stream bank stability. Turbidity goals varied by water body, but the targets were intended to correspond to suspended sediment ranging from 50 to 80 mg/L. Stream bank stability greater than 80% for all streams was set as an additional target. Targets for nitrogen (0.3 mg/L) and phosphorus (0.1 mg/L) apply throughout the year. For Blackfoot River, approximately 35% reduction of phosphorus is required, but varies depending on the segment/creek. An approximate reduction of 80% phosphorus will be required to meet the target, and a goal of no increase in nitrogen is indicated.

The Portneuf River Subbasin Assessment and TMDL was approved by EPA in 2001. The Portneuf River Subbasin has numerous documented water quality problems that affect beneficial uses. Sediments and nutrients are a concern in many listed segments, and the mainstem Portneuf River is also listed for bacteria, flow alteration, and oil and grease. Evidence indicates that other pollutants, such as temperature, metals, and PCBs, may also be impairing the waters in the Portneuf River subbasin (IDEQ 2001b). Several sources of pollutants have been identified. Agriculture has been implicated in flow alteration and contributing sediment and nutrients. Sediment can also originate from streambanks, streambeds, and natural processes. Livestock, wildlife and urban/suburban sources also contribute to non-support of beneficial uses (IDEQ 2001b).

The Upper Snake River Basin National Water Quality Assessment (NAWQA), which included sampling in the Portneuf River subbasin, found that nitrates in surface water are highest downstream from agricultural areas. Pesticides in surface water were generally found in the spring and early summer following early season applications and do not exceed established water quality criteria. Concentrations of organochlorine compounds in tissue of fish from the Portneuf River at Pocatello, Rock Creek near Twin Falls, and Snake River near Twin Falls equaled or exceeded national guidelines for the protection of fish-eating wildlife (Maret and Ott 1998).

Portneuf River bacteria load reductions of approximately 85% from May to September will be required to meet water quality standards. Suspended sediment targets (50 mg/L at low flows to 80 mg/L at high flows) will require approximately 65% reduction of current levels. The majority of reduction in sediment contributions is expected from agricultural land uses. Targets set for nitrogen and phosphorus will require 66% and 39% reduction, respectively. These reductions are for the lower Portneuf River near the Reservation boundary. In this portion of the river, springs and ground water contributions of nutrients can be significant.

Agricultural implementation plans have been developed for the Portneuf TMDL (ISCC 2003) and the Blackfoot TMDL (IASCD and ISCC 2005) which establish priority areas and appropriate best management practices (BMPs) to reduce agricultural nonpoint source pollutant contributions within the subbasins. The plans includes establishment of priority treatment units for riparian areas, irrigated crop land and pasture, dry crop land and pasture, rangeland, and animal feeding operations. Urban/suburban sources such as storm water runoff and septic systems have been addressed in the overall TMDL implementation plans. The IASCD/SCC will develop an implementation plan for the American Falls subbasin once the TMDL has been approved.

Aquatic Biology and Habitat Concerns

The TMDL process does not address all factors important to the quality of water and the aquatic system. Flow alteration, riparian vegetation, and instream habitat are outside the scope of the TMDL process, but still have critical impact on water quality, the health of the aquatic system, and the community structure. The Tribes has an on-going upper Snake River habitat restoration/enhancement project funded by Bonneville Power Administration (BPA) to address these issues.

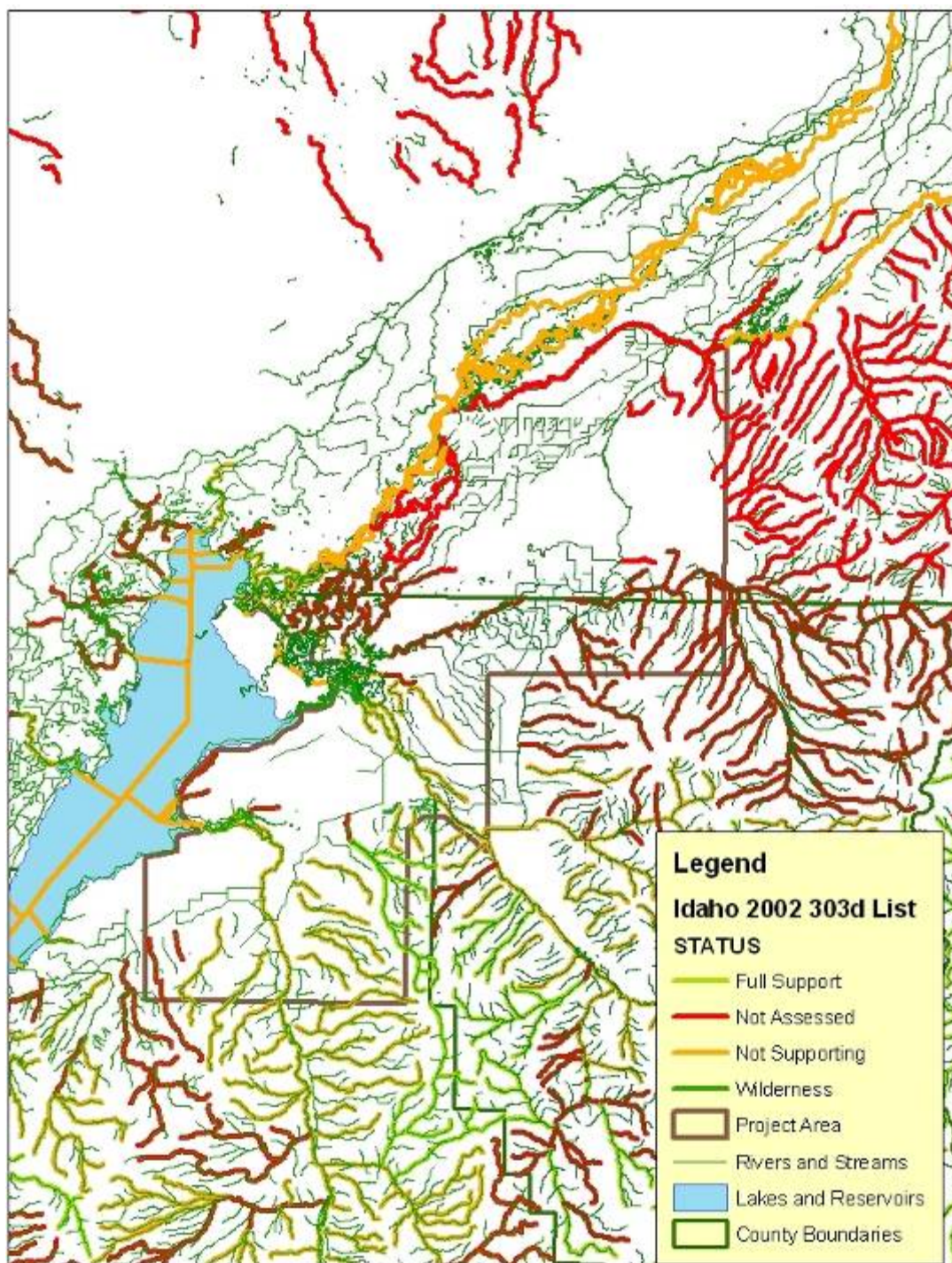


Figure 3. Status of water bodies within/adjacent to the project area, according to the Idaho 2002 303d list.

Table 7. Water bodies in and adjacent to the Fort Hall Indian Reservation deemed to be water quality limited (IDEQ 2001b, IDEQ 2002b, IDEQ 2004, IDEQ 2006b).

River/Stream Segment	Pollutants of Concern
<i>American Falls Reservoir</i> (17040206SK001L_0L, SK001_05)	DISSOLVED OXYGEN, NUTRIENTS, SEDIMENT ¹ , FLOW ALTERATION, TEMPERATURE ²
<i>Snake River</i> (17040206SK022_02)	SEDIMENT, TEMPERATURE ²
<i>Snake River, Ferry Butte to County ILine</i>	DISSOLVED OXYGEN ¹ , NUTRIENTS ¹ , SEDIMENT, FLOW ALTERATION, TEMPERATURE ²
<i>Bannock Creek</i> (17040206SK002_02, SK002_05)	NUTRIENTS, SEDIMENT, BACTERIA
<i>Moonshine Creek</i> (17040206SK006_02)	SEDIMENT
<i>Rattlesnake Creek</i> (17040206SK010_02, SK010_04)	SEDIMENT
<i>WF Bannock Creek</i> (17040206SK008_02)	SEDIMENT
<i>McTucker Creek</i> (17040206SK024_02)	SEDIMENT
<i>Blackfoot River</i> (17040207SK002_05)	SEDIMENT ³ , NUTRIENTS ³
<i>Wolverine Creek</i> (17040207SK030_03)	SEDIMENT ³ , NUTRIENTS ³ , HABITAT ALTERATION, FLOW ALTERATION
<i>Portneuf River</i> (17040208SK001_05)	BACTERIA ³ , NUTRIENTS ³ , SEDIMENT ³ , OIL AND GREASE ³ , HABITAT ALTERATION, UNKNOWN
<i>Portneuf River</i> (17040208SK020_03)	SEDIMENT

¹ TMDL proposes to delist.

² Not listed on 2002 303d List—TMDL proposes to add to next 303d List.

³ Addressed with approved TMDL.

Ground Water Quality

Ground Water Vulnerability and Contamination Sources

The primary land uses in the project area are agriculture, rangeland, and rural/urban. A high water table is maintained by percolation of surface-applied irrigation water and seepage from associated irrigation canals and ditches and area streams and rivers. Permeable soils coupled with relatively shallow depth to ground water make the aquifer particularly vulnerable to contamination from a variety of sources (van Steeter et al. 1998, Parlman 2002). According to vulnerability mapping studies (Rupert 1998) performed by the US Geological Survey (USGS), a large portion of the area is at high risk for contamination by nitrate and pesticides (Figure 4). A large portion of the project area falls with an IDEQ-designated nitrate priority area. Long-term and widespread use of agricultural fertilizers and chemicals has apparently impacted the shallow aquifer and portions of the regional aquifer. However, rural/urban sources have also likely contributed to the water quality problems. Changes in land and water uses (irrigation

methods, domestic wells, septic tank drainfield densities) have the potential to affect ground water recharge and quality (USGS 1998) but type and degree of impact has not been quantified.

Pathways of contamination due to land use (as described by USGS 1998) include: 1) seepage, leakage, or dumping of contaminants at or near the land surface; 2) downward flushing of contaminants by infiltration of precipitation, floodwater, or applied irrigation water; 3) flushing of contaminants from soil and rocks by seasonal variation in the water table; 4) leakage around or into well casings or dumping of contaminants into wells; 5) back-flushing contaminants to wells through water supply systems; and 6) transport from up-gradient sources. Statewide, IDEQ has listed priority source categories for contamination of ground water, including animal feedlots, fertilizer and pesticide applications (urban and agricultural), land application of sludge/wastewater, underground storage tanks, landfills, septic systems, shallow injection wells/urban runoff, and industrial facilities. These source categories are based on health risk, amount of population exposed, risk to drinking water, size of source, hydrogeologic sensitivity, or other findings (Clark 1998), and are shown in Figures 5 and 6 when location is known.

Wells

According to IDWR geodatabases, approximately 100 irrigation or domestic wells are located within the Gibson Terrace area. This likely underestimates the total number of wells, since only spatially-referenced wells (wells drilled since approximately 1990) are included. Residents in the project area rely on the aquifer as their primary source of drinking water. Wells can be a potential source of aquifer contamination either through poor siting or construction or contaminant disposal in or around the well – each individual well is a potential conduit for contamination to reach the aquifer. Many wells have incomplete or no well log data, so it is difficult to access the risk. Wells constructed with perforated casings through both the impacted shallow aquifer and the deep aquifer provide a conduit to contamination of the deeper aquifer. Many of the wells that have been sampled through various monitoring efforts in the Gibson Terrace area have elevated levels of nitrate. Bacteria and low-level pesticides have also been detected in some wells. Volatile pesticides have been detected above health advisory levels. The extent of threat due to abandoned wells is unknown.

Septic Systems

Conventional septic systems are not efficient at removing nitrogen, and many systems may not be properly sized. Aging, inappropriate or poorly maintained systems create even greater risk. In areas subject to high water tables or soils with high infiltration rates (Soils Maps, Appendix A), pollutants from septic systems may be transported to ground water. Likewise, septic systems located near drains, ditches or canals can directly contaminate surface water due to lateral flow to drains during periods of high ground water. Septic systems may be a localized source of contamination but will not be addressed in this plan.

Commercial/Industrial Sites of Concern

The Idaho Department of Environmental Quality administers several remediation sites adjacent to the Reservation:

- Two currently active Resource Conservation and Recovery Act (RCRA) sites (hazardous waste regulated by EPA), and three closed sites.

- Eight leaking under ground storage tanks (LUSTs) located near the project area (in and around Chubbuck) have completed clean-up per IDEQ's requirements under the LUST program (IDEQ 1996).
- One active AST (tank farm near Michaud Flats).

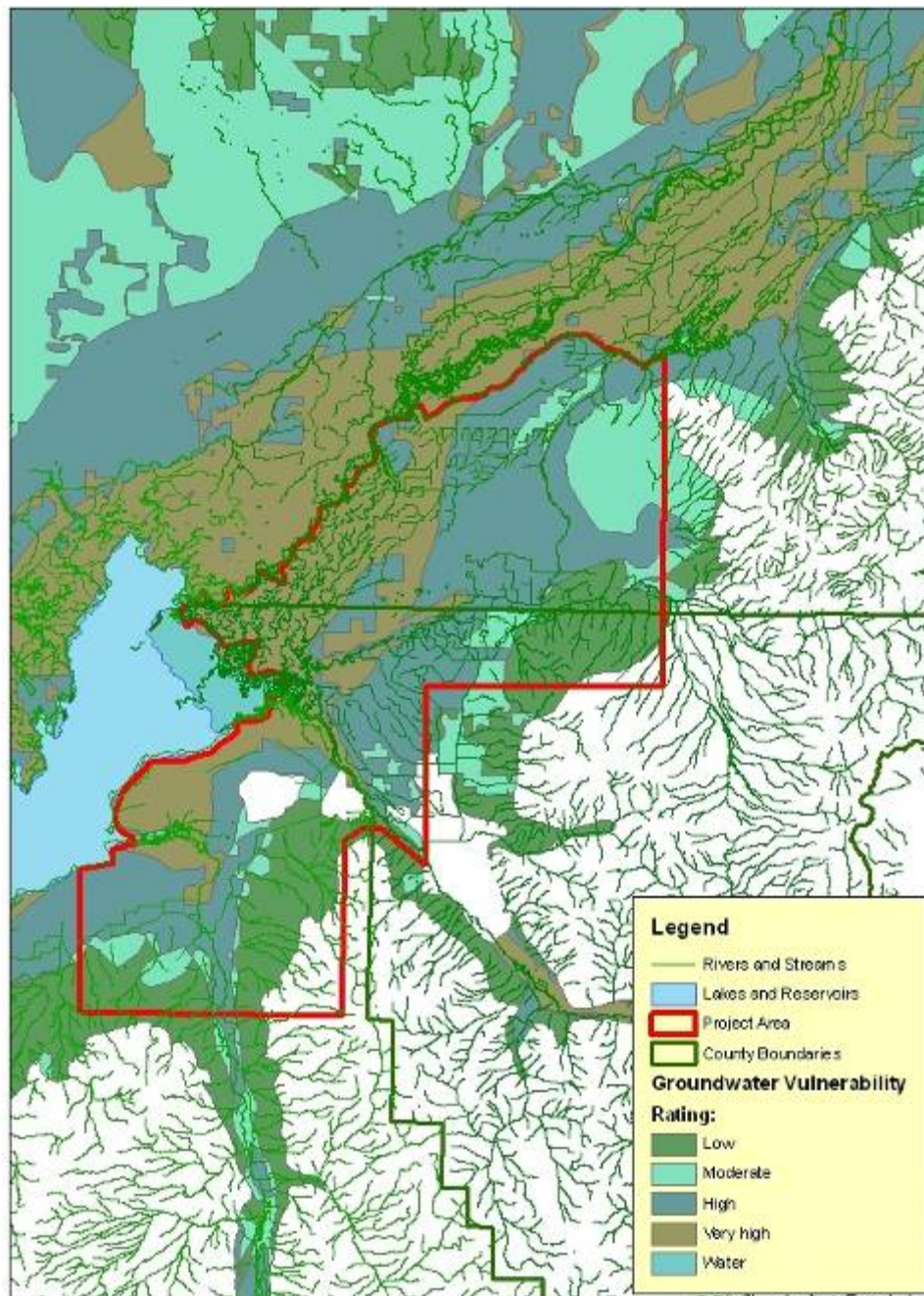


Figure 4. Ground water vulnerability ratings within the project area (IDWR database, 1995).

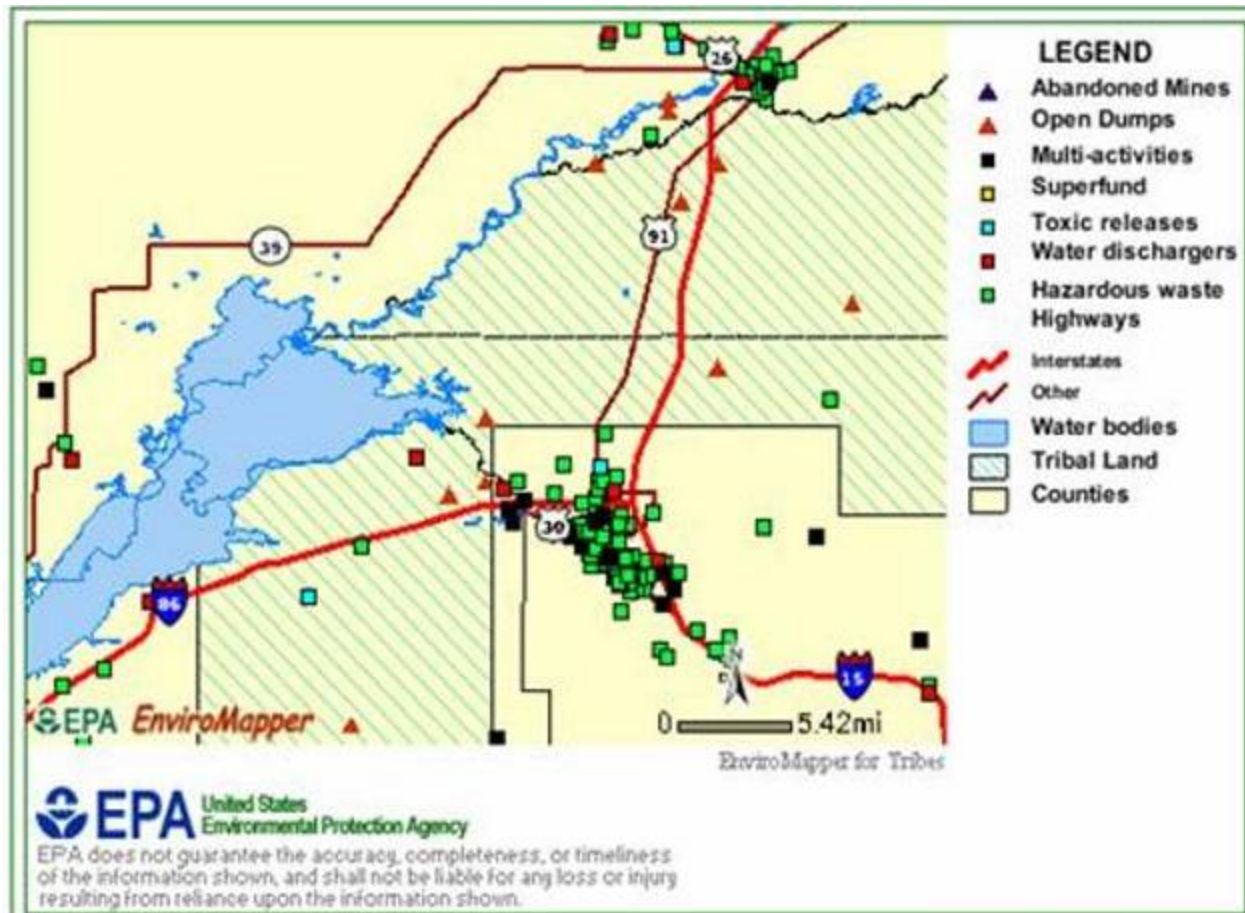


Figure 5. Potential contamination sources and/or dischargers on and adjacent to the Fort Hall Indian Reservation (from EPA Envirofacts database).

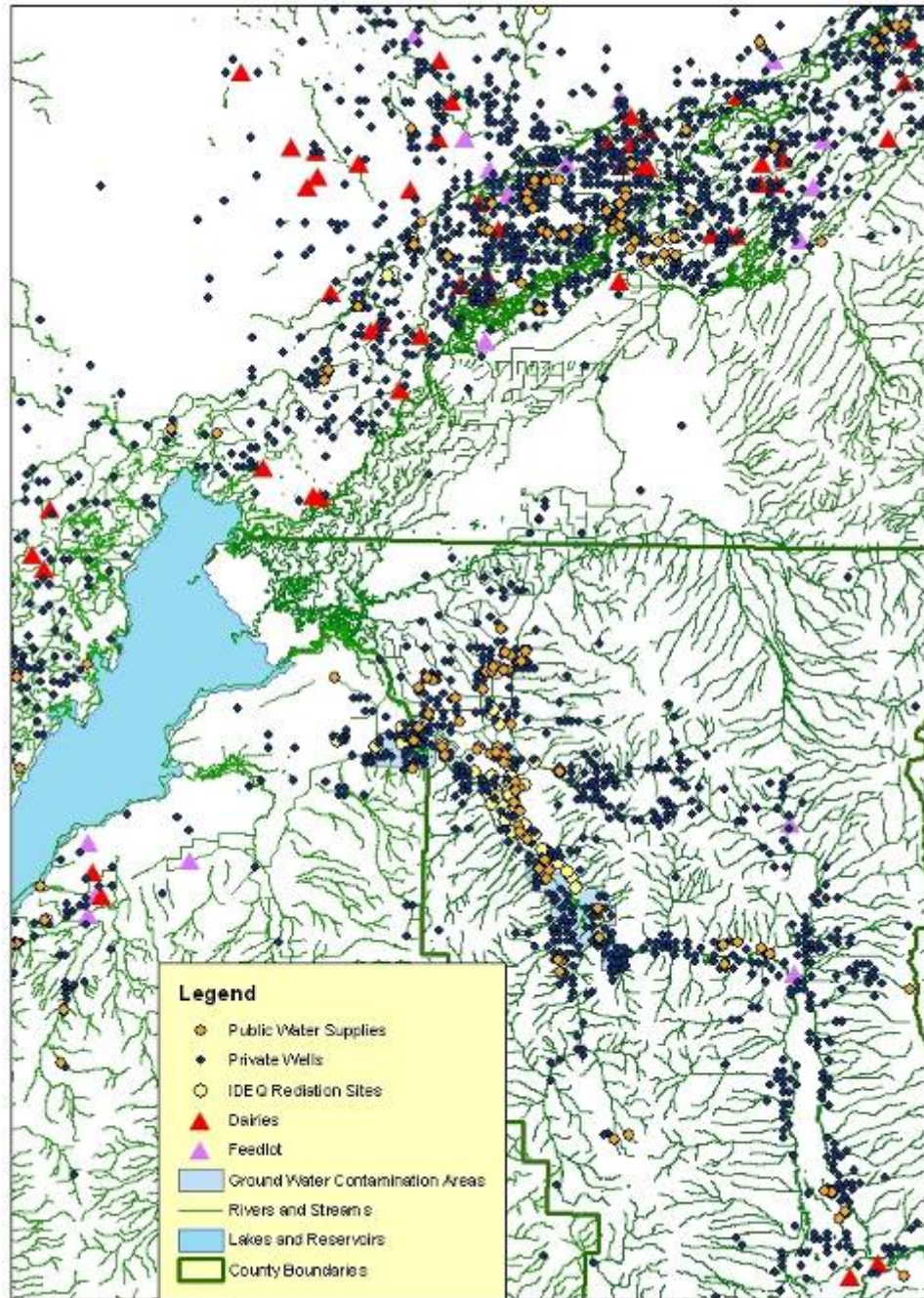


Figure 6. Contamination sites, private well locations, and Public Water Supply wells (from State of Idaho geodatabases).

Potential Agricultural Sources of Pollutants

Agrichemicals are the major sources of agricultural pollutants within the project area. The historic shift from rangeland to intensive crop production was associated with increasing use of commercial fertilizers and irrigation over the last 40 years (USDA-NRCS 1991). This change is

correlated with the apparent increasing trend in nitrate levels since the 1960s (Figure 7). The well samples taken from the Gibson Terrace area are consistently high across the area, which is indicative of broad-scale land use issues, and points to agriculture as the major land use in the area.

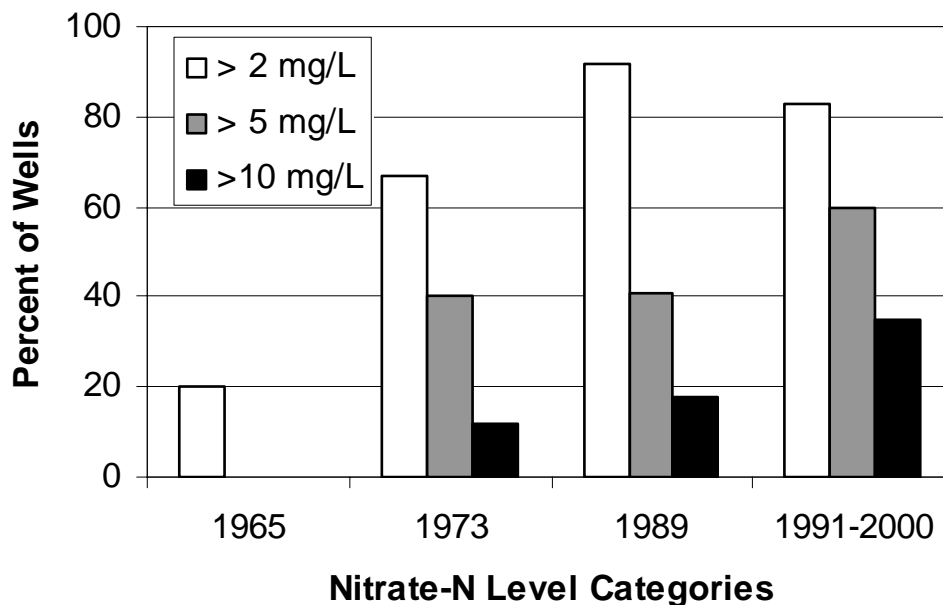


Figure 7. Apparent nitrate trends on Fort Hall Indian Reservation, 1960s – 2000, based on data from a variety of sources. The data from 1965 (approximate year) and 1973 is assumed to be from the area adjacent to Fort Hall townsite, but this is uncertain. The “apparent” trend is therefore not significant, but for illustration purposes only. The EPA health standard (MCL) for nitrate in drinking water is 10 mg/L.

Dairies and Feedlots

There are 2 AFO/CAFOs within the project area. One (<300 head) is located just northeast of the nitrate priority area, and one (between 1,000 and 5,000 head) is located near the Michaud Flats area. It is unknown whether the AFO/CAFOs have nutrient management plans and sufficient waste containment. Although some studies indicate little movement of nutrients below corral surfaces, ponding of water and preferential flow paths could allow transport of nutrients from AFO/CAFO yards. Field application of manure may be a localized concern due to high water tables and over application. Feedlots probably contribute little to the nitrate concerns in the overall project area.

Pastureland and Hayland

There are approximately 2,300 acres of pasture and hayland land within the project area. Potential risk to the aquifer from this land use is low under the current management practices. Irrigated pastures or pastures with saturated soil conditions may contribute nutrients through leaching, however bacteria are typically filtered through the top layer of soil and are generally not transported to ground water from pastureland. Proper grazing management and adequate pasture condition (composition and biomass) are important to prevent surface water quality impacts. Low inputs of agrichemicals are typical for hayland in the project area.

Agrichemical Use

Fertilizer applications and historic as well as current use of pesticides have impacted the aquifer in the project area. Areas of concern include use of pesticides with high risk potential, application of chemicals without validation of need (no IPM), over-application of fertilizer due to lack of nutrient management plans and/or replacement of leached nutrients for high nitrogen demand crops due to over-irrigation. Evaluations of fertilization and irrigation practices on crops have shown high levels of fertilizer application and irrigations that exceed the crop consumptive use requirement.

Irrigated Crop Land

Over-irrigation leads to deep percolation and translocation of mobile nutrients like nitrate, and certain pesticides below the root zone. Impacts are exacerbated by the high water table in some areas. Inefficient application of irrigation water by surface or sprinkler irrigation systems is a problem, and irrigation does not generally meet NRCS standards. The majority of crop land is sprinkler irrigated with center pivots, so irrigation efficiency and IWM are potentially high. Sprinkler irrigated crop land does not usually contribute runoff if the system is properly set up and maintained, but can contribute to deep percolation. Deep percolation is estimated to be 20-30% of water applied.

Ground Water Quality Summary

The majority of residents on the Fort Hall Indian Reservation get their drinking water from ground water sources (either private wells or community water systems). Ground water within the Reservation has been impacted and is a health concern. An area within and adjacent to the Fort Hall Indian Reservation ranks seventh on Idaho's list of ground water areas impacted by nitrates. This nitrate priority area is particularly vulnerable to ground water contamination due to the shallow aquifer overlain by sandy soils, and magnified by the low water level gradient which slows horizontal subsurface flow. Early monitoring studies identified ground water concerns within the project area, and the Shoshone-Bannock Tribes continue to monitor water quality on the Reservation.

Historic Ground Water Quality

The first documented ground water analyses at the Fort Hall Indian Reservation in the 1960s indicated that the majority of wells tested (sixteen) had nitrate levels below 1 mg/L, and none exceeded 5 mg/L (Taberna 1993). Much of the area was still in native rangeland, and crop land/hayland was irrigated primarily with hand lines and wheel lines. Additional testing by the US Public Health Services in 1973-4 showed an increase in nitrate levels, with 12% of 73 wells tested exceeding 10 mg/L, and just 33% with levels less than 2 mg/L (nitrate levels exceeding 2 mg/L indicate probable anthropogenic impact) .

Increasing concerns with nitrate and pesticide contamination on the Reservation led to additional testing by USGS in 1988-9. In the area of the Reservation bounded by the Fort Hall Main Canal (to the east) and Pocatello (to the south), USGS sampled 60 wells, with a mean nitrate plus nitrite nitrogen level of 4.7 mg/L and ranges from 1.7 mg/L to 19 mg/L. Additionally, four of 19 wells tested positive for fecal coliform or fecal streptococci. Depth to water for wells ranged from 12 to 90 feet. There was no clear correlation between level of nitrate contamination and depth to water, but wells most impacted by nitrates were primarily located in the Gibson Terrace area (Parlman and Young 1988). More intensive well sampling in the Gibson Terrace area (north of Fort Hall, south of the Gibson Canal) by USGS in 1989 indicated that almost 20% of wells exceeded the drinking water standard (10 mg/L). The mean nitrate plus nitrite nitrogen

level was 6.1 mg/L, with ranges from 1 to 17 mg/L (Parlman and Young 1989). Additional sampling in the southern portion of the Reservation (Michaud Flats area) indicated little nitrate impact. Mean nitrate plus nitrite nitrogen level was 1.0 mg/L, and only 4 wells exceeded 2 mg/L (Young and Parlman 1989).

A trend analysis performed by USGS in support of the IDEQ nitrate priority area designations showed 35% of wells sampled exceeded the drinking water standard. Mean nitrate level was 8.3 mg/L, and 83% of wells exceeded 2 mg/L. The nitrate priority area is indicated on Figure 8. Water quality data from 1991 to 2000 showed no apparent increasing trend in nitrate level.

Well sampling in conjunction with the initiation the Statewide Monitoring Program (IDWR in cooperation with USGS) in 1990 indicated additional health risks with the detection of pesticides, most notably EDB, in test wells on the Reservation. The statewide data indicated that wells with detections of 1,2 dichloropropane and ethylene dibromide (EDB) exceeded the Maximum Contaminant Levels (MCLs) (5 ug/L, 0.05 ug/L, respectively). Continued monitoring identified an area approximately 63 square miles in size where ground water was contaminated with EDB (USDHHS 2005). Monitoring by IDEQ in 1993 also discovered elevated EDB levels in a community well off the Reservation (USDHHS 2005). As of 1996, 109 wells on the Reservation had detectable levels of EDB ranging from 0.02 to 15 ppb (MCL is 0.05 ppb) (IDHW 2002). Other pesticide detections in the early 1990s included dacthal, dinoseb, metribuzin, pentachlorophenol (PCP), and breakdown products or contaminants of EDB (including trichloropropane and methylene chloride), and data is provided in the Preliminary Investigation Report (1991).

The preliminary investigation in 1991 conducted by NRCS in cooperation with the Shoshone-Bannock Tribes was initiated to identify specific problems leading to ground water contamination, develop potential solutions, and help determine appropriate project action and funding eligibility. Both point (specific source of pollutant, usually localized) and nonpoint (more diffuse, multiple sources, usually widespread) sources of pollutants can contribute to ground water quality degradation. A number of potential sources were evaluated during the preliminary investigation: 1) application or disposal of agricultural chemicals, 2) septic systems, 3) sewage treatment facilities, 4) landfills, 5) drainage systems, and 6) feedlots. Of these potential sources, agricultural chemicals were considered to be the greatest contribution to the problem, with septic systems also contributing. The preliminary investigation recommended a field monitoring demonstration project and expansion of the monitoring database. A cooperative project was begun in 1992, monitoring the use of best management practices (BMPs) on potato and wheat fields. Sixteen monitoring wells were constructed to expand water quality sampling. Mean nitrate level in monitoring wells was 17 mg/L in 1995 (NRCS 1996).

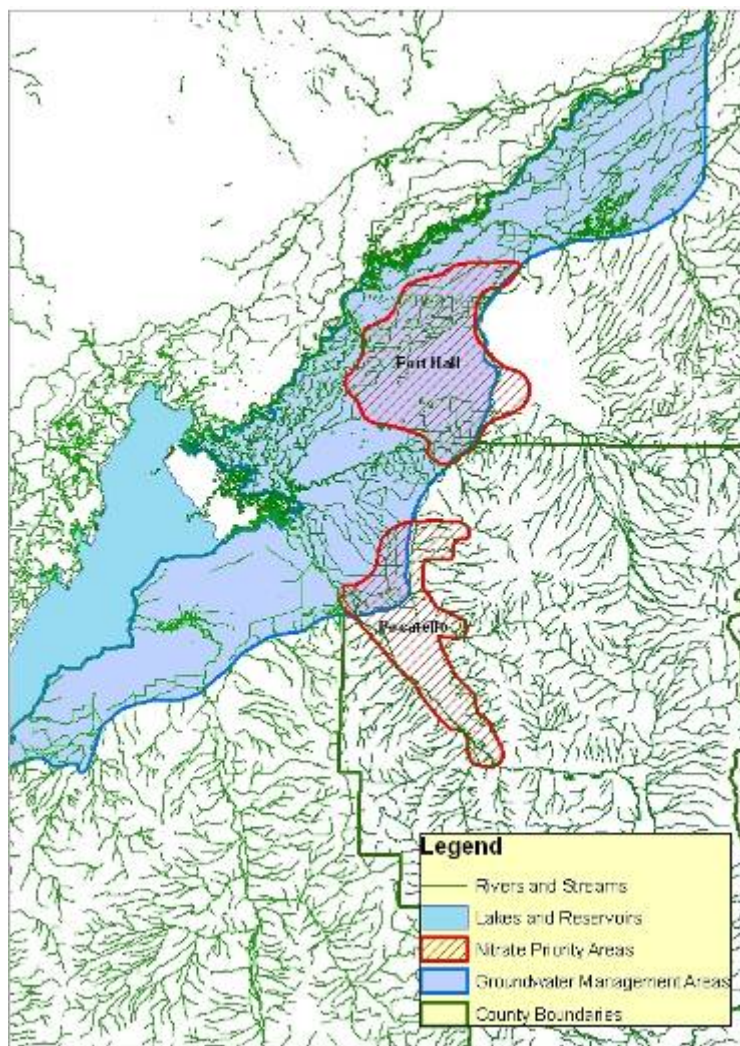


Figure 8. Nitrate priority areas, and IDWR ground water management area designated for water quantity concerns.

Current Ground Water Monitoring Results

IDEQ is designated as the primary agency in Idaho to coordinate and administer ground water quality protection programs for the state (Idaho Code § 39-120). According to the Idaho Ground Water Quality Plan (GWQC 1996), IDWR is responsible for the statewide monitoring program, and has performed well monitoring in the project area since 1991. Figure 9 summarizes the nitrate results from IDWR's monitoring program in Bingham County from 1991-2000. An update of nitrate monitoring results provided additional sampling information (IDWR 2006, Figure 10). Trend analysis from 1991 to 2003 indicates no apparent increasing or decreasing trend in the Fort Hall Nitrate Priority Area (Neely 2005) between the first (1991-1994), second (1995-1998), or third round (1999-2003) of monitoring. Where land use activities contributing to degraded ground water quality involve agricultural practices, ISDA provides monitoring and assessment, and recommendations of needed BMPs for the state. ISDA ground water monitoring in the Eastern Snake River Plain off the Reservation began in 1998 and ended in 2002 due to "good water quality determined over the initial five years of monitoring." Statewide monitoring in

2003 and 2004 identified several wells with “detections of concern” near Fort Hall, and these detections included high nitrate levels, volatile organic compounds, and pesticides.

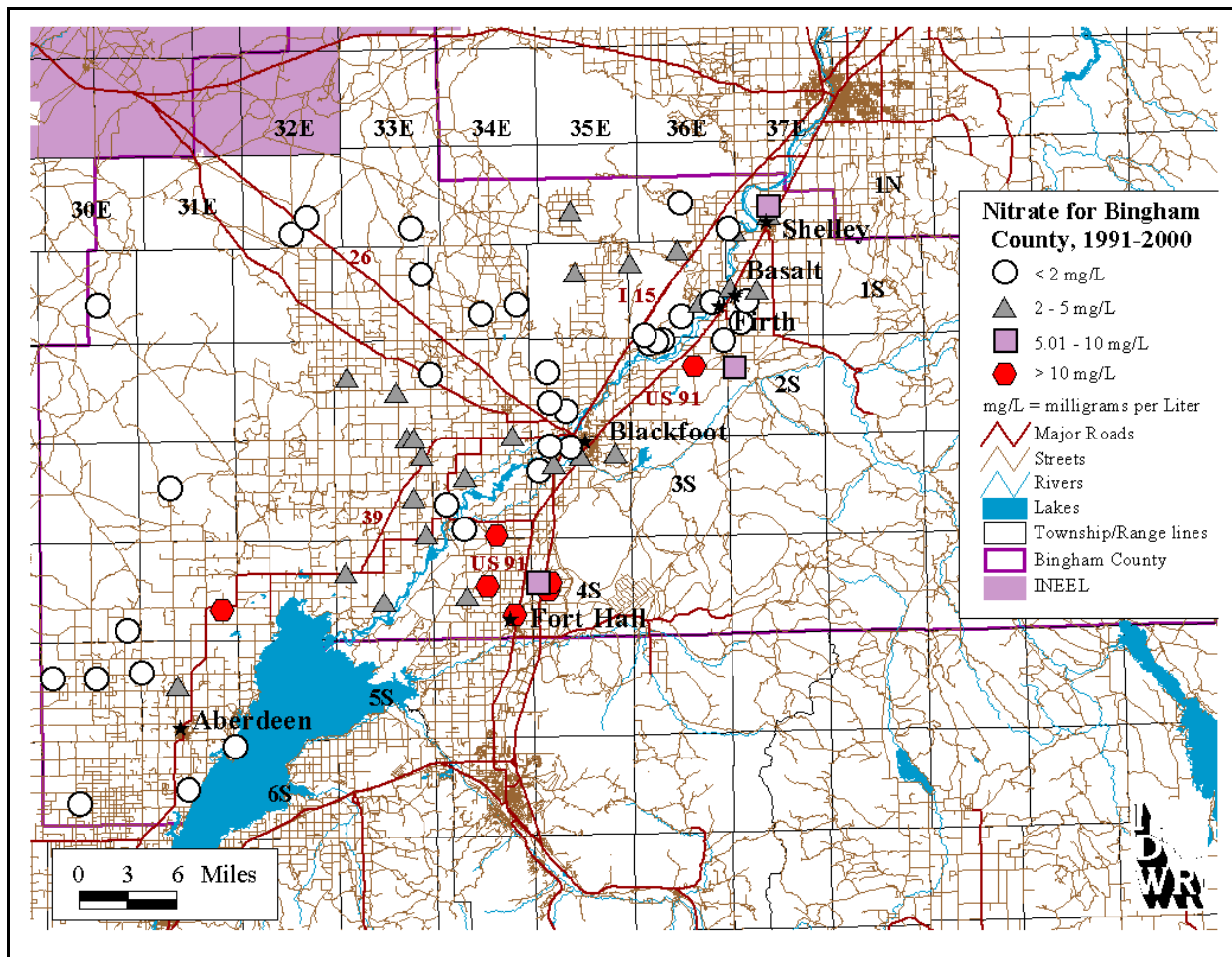


Figure 9. Nitrate results from the Statewide Monitoring Program in Bingham County from 1991 to 2000. The high nitrate levels discovered in the Fort Hall – Gibson Terrace area are indicated in red (from Neely 2002).

The Shoshone-Bannock Tribes have a ground water quality monitoring network established on the Reservation, and continue to monitor for a variety of constituents. Several reports have been completed summarizing and analyzing the Reservation data.

Ground Water Contaminants

Nitrate

Nitrate contamination of ground water is the most widespread, preventable contaminant in ground water. Major sources of nitrate in Idaho are inorganic fertilizers, decaying organic matter, waste matter, animal waste and human sewage (Neely and Crockett 1999). On a statewide basis, over 90% of nitrate contamination is associated with agricultural sources (IDEQ 2001a). Twenty-five nitrate priority areas have been identified throughout Idaho. These areas have significant ground water quality impacts due to nitrate contamination. Nitrate priority areas

have greater than 25 % of their ground water wells over 5 mg/L. Fort Hall has been designated the seventh ranked nitrate priority area by IDEQ (2002a).

Levels exceeding 10 mg/L can impact human health, and levels exceeding 20-40 mg/L can impact livestock (IDEQ 2001a). Methemoglobinemia (Blue Baby Syndrome), which leads to an oxygen deficiency in infants, can occur from ingestion of water with elevated nitrate levels. Elevated nitrate levels may also pose problems for pregnant women and the elderly infirm. Long-term effects of drinking nitrate-contaminated water are unknown (Neely and Crockett 1999, EPA 2004a).

Monitoring data from 1999-2000 resulted in a mean nitrate level of 9.6 mg/L for wells sampled (10), with a maximum value of 22 mg/L. Based on the 2003-4 sampling, the mean nitrate levels for wells sampled as part of the Statewide Monitoring Network (6) was 12.3 mg/L in the Gibson Terrace area (shallow alluvial aquifer) with a maximum of 24 mg/L, 2.9 mg/L in the area between Fort Hall and Chubbuck, and less than 2 mg/L in the Michaud Flats area (Figure 10). A ground water management plan for the Fort Hall Nitrate Priority area is scheduled for completion in 2009 (IDEQ Regional Office, Pocatello).

Pesticides

Ethylene Dibromide (1,2-dibromoethane)

Ethylene dibromide (EDB) is a manufactured, toxic colorless liquid, historically used as a pesticide (soil fumigant) and as an additive to leaded gasoline. In 1984 its use as a pesticide was banned by EPA. Health effects from ingestion of EDB include damage to the nervous system, heart, liver and kidneys with chronic exposure. It is also a probable human carcinogen. Exposure via skin contact or inhalation can cause health effects as well. Acute exposure to high levels of EDB can cause liver, stomach, adrenal cortex and reproductive system damage (IDHW 2002).

A site assessment conducted by EPA in the mid 1990s did not identify a point source for the EDB contamination. The application and handling of this soil fumigant on potatoes in the past is a potential source. IDEQ sampling, as a follow-up to the EPA-initiated sampling, has identified an area of EDB contamination off the Reservation. Fifty two wells were sampled in 2004 in an area northwest of Chubbuck to just west of the Portneuf River, with 20 detections of EDB. No statistical trends were identified when comparing 1997 and 2004 data, but concentration levels appear higher in wells located within basalts than in sand/gravels. No known EDB applications occurred off the Reservation, but potatoes have been cultivated in portions of this area, and so EDB may have been applied. Limited water quality monitoring just up-gradient of the off-Reservation EDB detections has shown some detections of EDB (J. Pappani, personal communication). It is not clear whether the off-Reservations detections are the result of a contamination plume moving from the Reservation with the ground water flow (Safford 2005) or an unidentified source of contamination (e.g., past applications of EDB on potatoes). The potential EDB-contaminated ground water plume identified in USDHHS (2005) and DeJongh (1996) is identified in Figure 11. The Statewide Monitoring Network detected EDB in wells sampled in the Gibson Terrace area of the Reservation. Detections ranged from a high of 20.2 ppb in 1991 down to 1.5 ppb in 2004 for the most impacted well in the data set. Related contaminants continue to be detected in the shallow aquifer, including dichloropropane and trichloropropane, both of which can be contaminants or breakdown products of EDB.

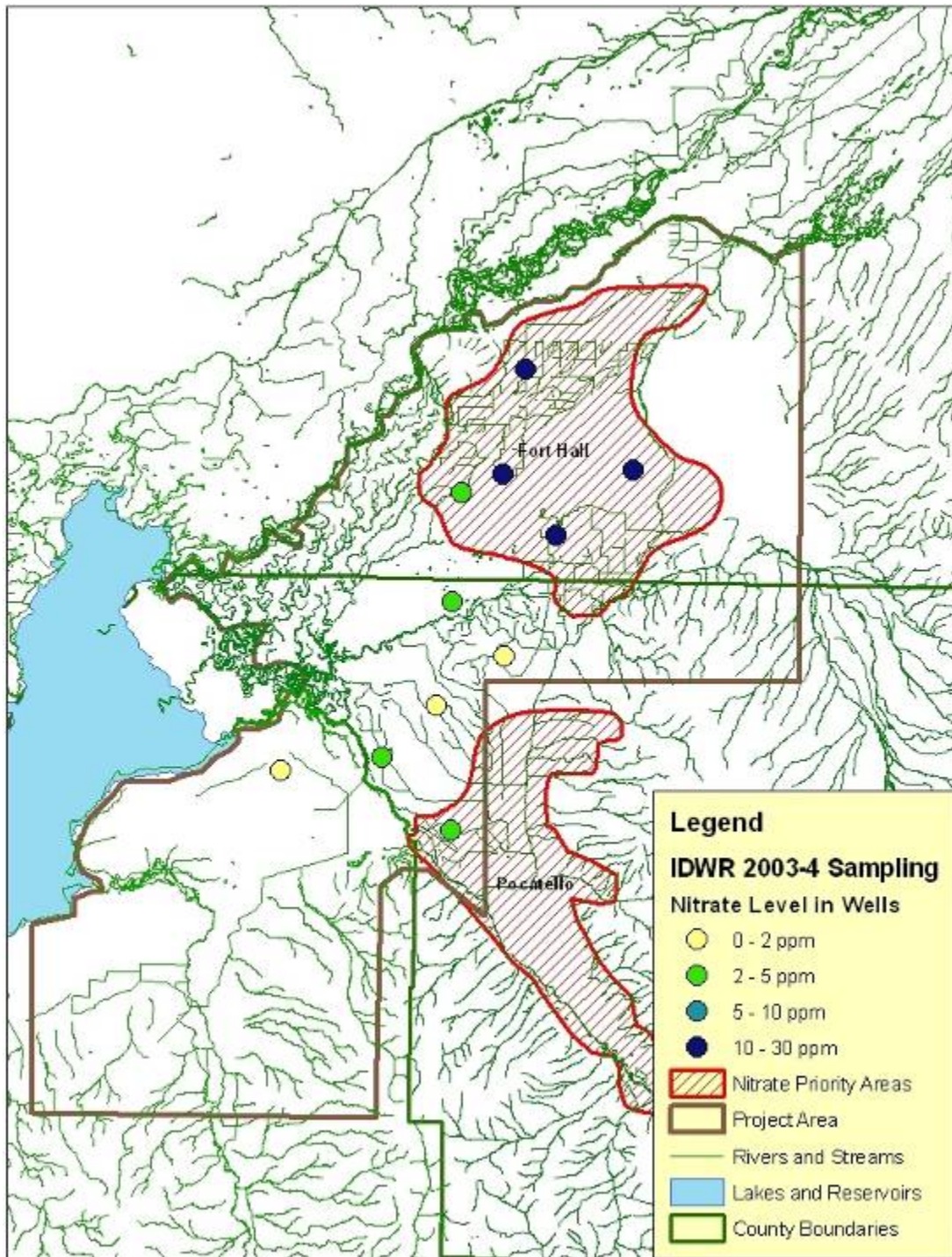


Figure 10. Most recent results from the Statewide Monitoring Program (2003-2004).

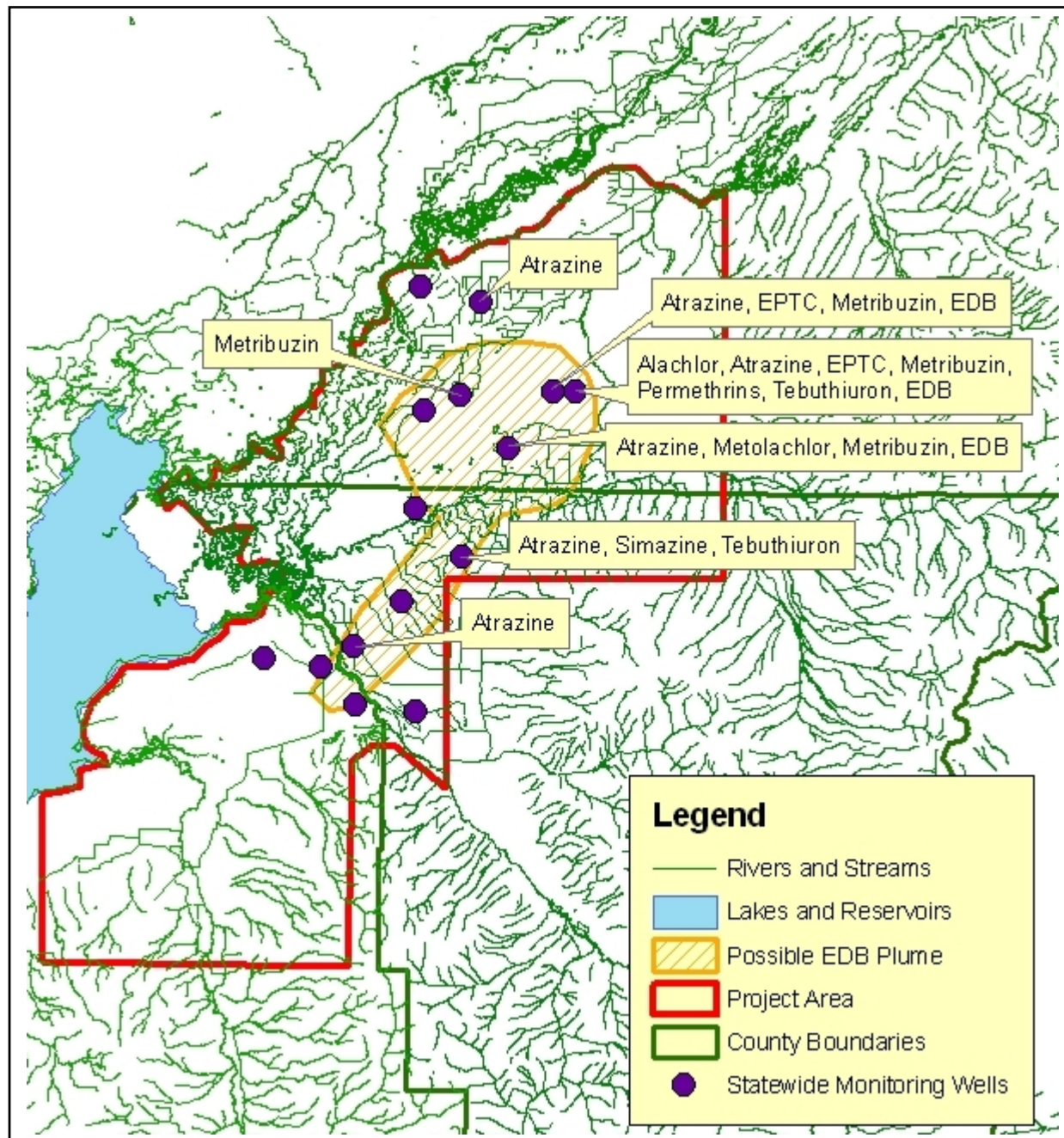


Figure 11. Location of pesticide detections from the Statewide Monitoring Program conducted in 1995 and 1999, including EDB.

Other Pesticides of Concern

In 1999, a soil analysis was conducted by USGS in cooperation with the Tribes and EPA to examine the potential for 1,3-dichloropropene (DCP, "Telone") and sodium N-methyldithiocarbamate (metam sodium) to impact ground water. Degradation products of these pesticides can be quite hazardous, and were detected in about 40% of soil samples taken.

Detections were not correlated with soil characteristics or use history. The pesticides/degradation products persisted in some soils greater than 6 months and were found to depths of at least three feet. These soil fumigants, used primarily as a pre-plant treatment, have not been detected in ground water to date, but the study suggests that they pose a risk to ground water. EDB was also detected in soils, even though its use was discontinued in 1983. This could have been a result of using contaminated irrigation water.

Other pesticide detections, although below MCLs or Health Advisory Levels (HALs), are an indication of aquifer vulnerability and ground water impacts most often due to agricultural land use. Pesticides most recently detected in the Statewide Monitoring Network wells include atrazine, atrazine desethyl (breakdown product of atrazine), alachlor, metolachlor, metribuzin, EPTC, tebuthiuron, permethrins, and simazine (Figure 11). Table 8. shows the hazard associated with these and other pesticides used within the project area.

Table 9. Table summarizing WINPST results. WINPST is an environmental risk assessment model used to determine hazard ratings of pesticides based on soil and chemical properties, and management activities.

Pesticides: Insecticides, Fungicides, Nematocides, Herbicides		Hazard Rating¹					
		Leaching Risk		Runoff Risk		Erosion Risk	
		Human Hazard	Fish Hazard	Human Hazard	Fish Hazard	Human Hazard ²	Fish Hazard
Hazard Ratings:							
L	Low or Very Low						
I	Intermediate						
H	High						
X	Extreme						
U	Unknown, no data						
Common Name	Active Ingredient						
1,4 Sight	Naphthalene	I	L	I	L		L
Aatrex Nine-O, 4L	Atrazine	H	I	H	I		L
Achieve	Tralkoxydim	I	L	I	L		L
Actara	Thiamethoxam	H	L	H	L		L
Agrimek	Abamectin	L	I	H	X		H
AgriTin	Fentin hydroxide	H	H	X	X		L
Asana	Esfenvalerate	L	I	L	X		H
Avenge	Difenzoquat methyl sulfate	L	L	L	L		L
Azatin	Azadirachtin	L	I	L	L		H
Baythroid, Renounce	Cyfluthrin	L	I	L	H		I
Bronate	Bromoxynil	I	H	L	I		L
BT	Bacillus thuringiensis	L	L	L	L		L
Buckle	Triallate + trifluralin	H	X	H	X		L
Carbaryl	Carbaryl	L	L	I	I		L
Clean Crop Amine 4	2,4 D dimethylamine	L	L	L	L		L
Clarity, Vanquish	Dicamba	L	L	L	L		L
Copper sulfate	Copper sulfate	L	I	L	H		L
Crossbow	Triclopyr (butoxyethyl) + 2,4 D	L	I	L	I		L
Curtail	2,4 D amine + clopyralid	L	L	L	L		L
Declare	Methyl parathion	L	L	H	H		L
Diazinon	Diazinon	X	X	X	X		H
Dibro, Krovar	Bromacil + diuron	I	I	I	I		L

Direx, Karmex	Diuron	I	I	I	I		L
Disyston	Disulfoton	H	I	X	H		L
Dithane DF	Mancozeb	H	H	H	H		L
Dual Magnum	Metolachlor	L	I	L	I		L
Embark	Mefluidide	L	L	L	L		L
Endura	BAS 510	L	L	L	L		L
Eptam 7E	EPTC	L	L	L	L		L
Express	Tribenuron-mthyl	H	L	H	L		L
Far Go	Triallate	H	I	H	I		L
Furadan	Carbofuran	I	H	L	H		I
Gaucha MZ ³	Imidacloprid + mancozeb	H	H	H	H		L
Gavel DF	Mancozeb + zoximide	H	H	H	H		L
Guthion	Azinphos-methyl	L	I	I	X		I
Harmony Extra	Thifensulfuron methyl	L	L	L	L		L
Headline	Pyraclostrobin	L	I	L	H		L
Hoelon	Diclofop-methyl	H	L	X	I		L
Hyvar	Bromacil	L	L	L	L		L
Imicide	Imidacloprid	L	L	L	L		L
Imidan	Phosmet	L	L	H	H		L
Kocide	Copper hydroxide	L	H	L	H		L
Maxim ³	Fludioxonil	L	I	L	I		L
Mertect	Thiabendazole	U	I	U	I		L
Methoxychlor	Methoxychlor	L	X	I	H		L
Mocap	Ethoprop	I	X	I	X		I
Moncut DF	Flutolanil	L	L	L	L		L
Monitor	Methamidophos	I	L	H	L		L
Oust	Sulfomethuron methyl	L	L	L	L		L
Permethrin	Permethrin	L	I	L	H		L
Phaser	Endosulfan	L	I	I	X		H
Pin Nip	Chlorpropham	L	L	L	L		L
Princep	Simazine	H	L	H	L		L
Prowl 3.3 EC	Pendimethalin	L	H	L	H		L
Redeem	Triclopyr (triethylamine) + Clopyralid	L	L	L	L		L
Rely	Glufosinate	L	L	L	L		L
Remedy, Garlon	Triclopyr (butoxyethyl)	L	I	L	I		L
Ridomil Copper	Mefenoxam + copper hydroxide	L	I	L	I		L
Ridomil Gold EC	Mefenoxam	L	H	L	H		L
Sencor	Metribuzin	L	L	L	L		L
Sprakil SK-13	Diuron + tebuthiuron	I	I	I	I		L
Spike	Tebuthiuron	L	L	L	L		L
Stalker	Imazapyr	U	L	U	L		L
Stinger	Chlorpyralid	U	L	U	L		L
Success, Spintor	Spinosyn A	L	L	L	L		L
Telar	Chlorsulfuron	L	L	L	L		L
Temik	Aldicarb	H	H	H	H		L
Telone	1,3-dichloropropene	H	L	H	L		L
Thimet	Phorate	L	I	H	X		I
Vapam	Metam-sodium	H	I	H	I		L
Velpar	Hexazinone	L	L	L	L		L

Vydate	Oxamyl	L	L	L	L		L
Weedmaster	2,4 D amine + dicamba	L	L	L	L		L
Weedone	2,4 D butoxyethyl ester	L	I	L	I		L

¹ Based on WinPST using sandy loams soils with typical application methods and rates.

² Human hazard is not associated with adsorbed runoff (soil attached) based on the assumption that humans do not ingest soil.

³ If used as a seed treatment, hazard is reduced.

Pathogens

Monitoring by IDWR has shown fecal coliform contamination in only one well in the project area. Bacteria contamination in wells is most often indicative of wellhead contamination or more localized water quality problems.

Protection of Public Drinking Water

Based on water quality monitoring data and, in particular, the pesticide detections exceeding the MCLs, EPA issued an Emergency Administrative Order in 1994 to address the health concerns when EDB was detected in the Tribal public water supply. Sampling efforts in conjunction with this Order defined the area of contamination but did not identify any point source. A health risk assessment performed by US Public Health Service at that time concluded that levels of EDB detected in private well samples posed an unacceptable cancer risk (USDHHS 2005). The contamination was so extensive that the Tribes had to abandon existing production wells, and construct new wells/connect to existing wells outside of the contamination area. They also constructed a water delivery system to provide safe water to affected homes (EPA 2005). Current ground water data from IDEQ's monitoring effort has recently been used by US Public Health Service to reevaluate the EDB risk off Reservation, given the revised cancer risk factor for EDB. They conclude that current levels of EDB measured in private and community wells off Reservation pose no apparent public health hazard at this time. A revised assessment has not been initiated for the Fort Hall Indian Reservation.

EPA's "Drinking Water Quality in Indian Country: Protecting Your Sources" outlines steps to assist with source water assessment, including delineation of the area that may contribute to source water contamination, contamination source inventory, susceptibility analysis, and public distribution of findings.

Summary and Implications

Sampling done by USGS, EPA, IDWR, IDEQ, and the Shoshone-Bannock Tribes has demonstrated past water quality degradation and continuing problems with nitrates and pesticides (and other volatile chemicals) in area wells. Of particular concern is the lack of improvement in nitrate levels over the past 15 years in the Fort Hall Nitrate Priority Area, and the continued detections of currently applied pesticides. There is a very strong relationship between land use activities and ground water quality (GWQC 1996). Water management practices as well as land uses, in combination with the hydrogeologic conditions, can increase the potential for ground water quality degradation, threatening ground water beneficial uses.

The primary source of ground water impacts is apparently agricultural land use (past and present, including storage and disposal). Potential identified sources such as poor well construction and failed septic tanks are generally local scale issues — the extent of ground water contamination on and off the Reservation is indicative of broad scale land use issues and

the intrinsic vulnerability of the aquifer (Focazio et al. 2002, Parlman 2002, Donato 2000). Particular attention needs to be paid to a high level of irrigation water and nutrient management, and incorporation of Integrated Pest Management (IPM) planning, to reduce further risks to the shallow aquifer and the deep regional aquifer.

Irrigation and Fertilizer Risk Assessment

Agrichemical Use

Fertilizer applications and historic as well as current use of pesticides have impacted the aquifer in the project area. Areas of concern include use of pesticides with high risk potential, application of chemicals without validation of need (no IPM), over application of fertilizer due to lack of nutrient management plans and/or replacement of leached nutrients for high nitrogen demand crops due to over irrigation. Evaluations of fertilization and irrigation practices on crops have shown high levels of fertilizer application and irrigations that significantly exceed the crop consumptive use requirement.

Field Studies

Studies conducted by ISDA (Fort Hall Water Quality Project (FHWQP), 1992-94), University of Idaho (PROJECT NO: 061-K264 - Irrigation and Nutrient Management for Maximum Potato Production Efficiency, 1993) and FHWQP (Soil Nitrogen Residues following Wheat and Potato Fields on the Fort Hall Indian Reservation, Fort Hall, Idaho, 1994) clearly demonstrate the problem of over application of nitrogen in a potato/grain/potato/grain (P/G/P/G) rotation on sandy soils. Nitrogen management on a crop like potatoes is difficult under the best of field conditions. The problem is escalated by having to manage nitrogen on loamy and sandy soil, where the grower has to balance adequate irrigation and adequate nitrogen management. Figure 12 illustrates the potential soil and soil solution nitrate-N levels and the potential nitrogen loss from the over application of nitrogen in combination with over application of moisture.

The data utilized in the model was based on data from Field #2, Site 2-4, WQIP, POLLUTION PREVENTION PROJECT, 1993 (refer to Tables 9 thru 15). The model simulation mirrors the actual field data where nitrogen application was applied at a rate of 360 pounds of N per acre (118 lbs/A in excess of crop uptake) and 4.0 inches per acre in excess of crop ET. The actual field data (Table 9) shows a carryover of 52 pounds of nitrogen with a post-season surface soil test N increase of 13 parts per million (ppm). The study site was monitored by lysimeters. The lysimeter data shows a range of 30 to 58 ppm solution nitrate-N (Table 14) sampled during the course of the irrigation season. The significance of the model illustration as compared to the actual data demonstrates the potential magnitude of the actively moving nitrogen under the traditional nitrogen and irrigation management practiced in Zone 1.

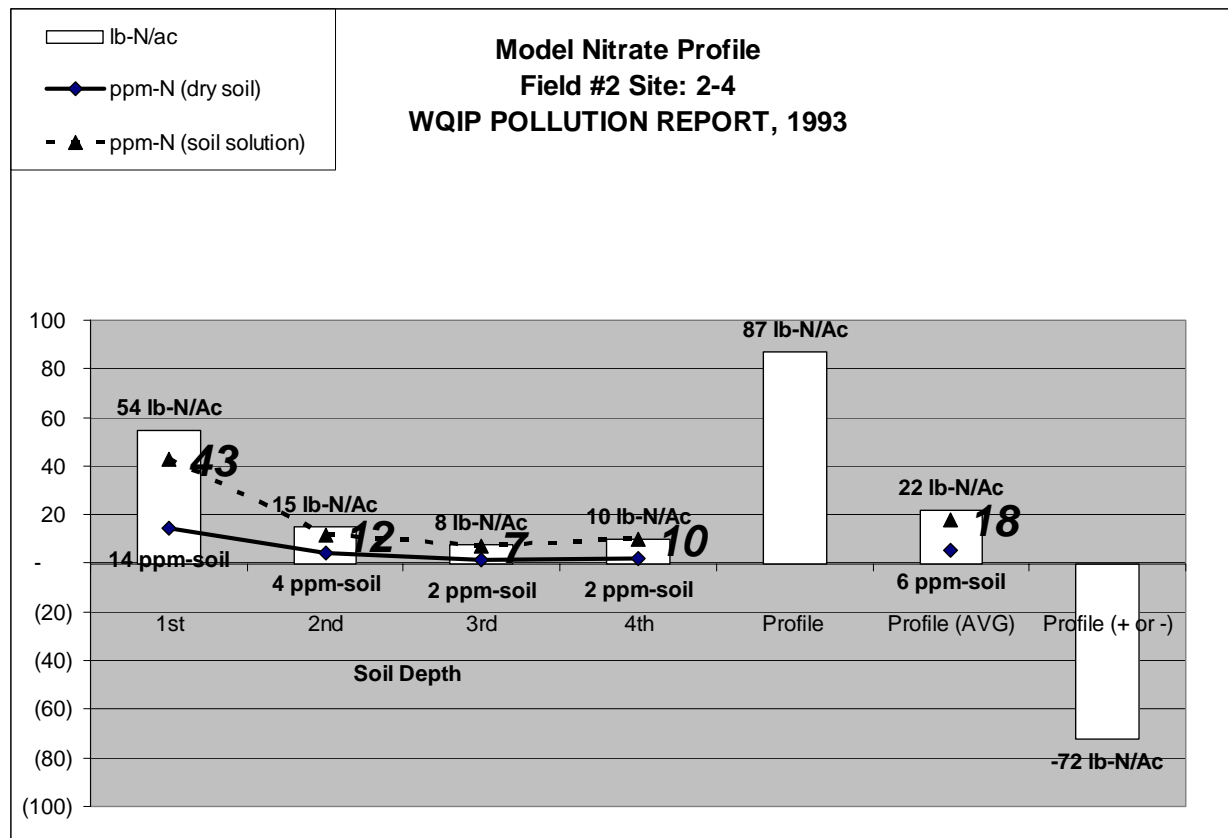


Figure 12. Modeled Nitrate Profile on Fort Hall Indian Reservation, Field #2, Site 2-4, based on data from the WQIP POLLUTION PREVENTION REPORT, 1993. The model shows the potential nitrate-N movement from 35 lbs/ac under 4.0 inches of irrigation on a loam soil surface underlain by sand. The potential soil and solution nitrate-N and the potential loss of nitrate-N from the productive root zone are estimated.

The 1993 University of Idaho study (PROJECT NO: 061-K264) validated the WQIP project findings, and found that the cultural practices as discussed not only affect yield, but maximum marketable yields were usually obtained with total N fertilizer rates between 300 and 350 pounds of nitrogen per acre and total seasonal irrigation amounts within 2 inches of seasonal crop water use. The best nitrogen fertilizer rates were between 300-320 units on sand and 220-280 units on loam soils. These units were for Russet Burbank potatoes; newer varieties require less nitrogen. The study also showed that improved water management reduced the incidence of hollow heart and brown center when early season fertilizer (before July 1) was held below 200 pounds of nitrogen per acre and moisture was kept at moderate levels.

Table 9. The amount of nitrate carryover between the preseason and postseason soil nitrate samples for Field #2, Site 2-4 (WQIP Pollution Prevention Report, 1993).

Site Identity	Soil Depth (ft)	Preseason Nitrates	Postseason Nitrates	Pre-Post Difference
2-4	1	3	13	10
2-4	2	4	5	1
2-4	3	5	5	0
2-4	4	9	6	-3
2-4	5	7	9	2
2-4	6	6	6	0

Carryover N ppm: 13
 Carryover N Units: 52
 Fertilizer N applied: 360
 Plant N uptake: 242
 Irrigation > ET: 4.0

Table 10. Potato nitrogen requirements and N applications for Field #2, Site 2-4 (WQIP Pollution Prevention Report, 1993).

	Nitrogen Uptake Rates			APPLIED	APPLIED -VS- UPTAKE
DATE	VINES	TUBERS	TOTAL	TOTAL	DIFFERENCE
7/1	90	55	145	255	110
7/9	140	94	234	290	56
7/23	113	129	242	320	78
8/12	70	126	196	345	149
8/25	56	129	186	360	174

Table 11. Crop growing season for Field #2, Site 2-4 (WQIP Pollution Prevention Report, 1993).

Planting:	4/22
Emergence:	5/25
Vine kill:	8/27

Table 12. Fertilizer Records for N Application for Field #2, Site 2-4 (WQIP Pollution Prevention Report, 1993).

Season	Units N/acre
Fall	56
Spring	18
Topdress	90
Inline	196
Total	360

Table 13. Soil and petiole nitrates (ppm) and weekly and total (accumulative) nitrogen applied for Field #2, Site 2-4 (WQIP Pollution Prevention Report, 1993).

DATES:	Soil Nitrates		Petiole Nitrates	Weekly N	Accum. Applied Nitrogen
	1st Foot	2nd Foot			
6/14	17	10	30000	36	200
6/21	14	10	27100	30	230
6/29	22	13	23600	25	255
7/7			25200	35	290
7/12	9	7	22500	20	310
7/20	11	6	17400	10	320
7/27	4	7	14500	12	332
8/9	8	10	12312	28	360
			Totals:	196	360

Table 14. Lysimeter results for Field #2, Site 2-4 (WQIP Pollution Prevention Report, 1993).

DATE	Nitrate (ppm)		Water extracted (ml)	
	Lys 1	Lys 2	Lys 1	Lys 2
7/30	49	NS	30	NS
8/3	NS	NS	NS	NS
8/9	58	NS	35	NS
8/19	NS	NS	NS	NS

Table 15. Sample Weights from Ten Foot Digs (lbs) and Estimated Total Yield (cwt/acre) for Field #2, Site 2-4 (WQIP Pollution Prevention Report, 1993).

DATE	Vines	Tubers	Yields
7/9	21.7	20.5	298
7/23	36.8	32.1	466
8/12	22.7	39.8	578
8/25	10.8	37.9	550

Risk Assessment Model

Table 16 shows the results of the NRCS risk assessment model (INTRA – Idaho Nutrient Transport Risk Assessment). The greatest risk is associated with nitrogen application rates and soil properties. Recognizing these risks, along with irrigation management, will assist in determining the appropriate conservation practices (or BMPs) to apply. The NRCS conservation practices Nutrient Management (590) and Irrigation Water Management (449) are key elements to reduce the net movement of nitrogen in Zone 1 fields. The P/G/P/G rotation has been a major income resource for the Fort Hall Indian Reservation, however the over application of nitrogen and irrigation water presents a major potential source of nitrogen to the ground water resource.

The carryover nitrogen in the vines could be considered an additional source of environmental nitrogen if that nitrogen is not utilized by the rotational crop following the production of potatoes. The crop rotation could be improved by considering crops that have deep rooting systems with ability to utilize deep soil profile nitrogen. The crop selection also needs to consider when the active uptake of nitrogen is taking place. Research conducted by USDA-ARS (Robbins and Carter 1980) in the Magic Valley demonstrated that the biologically fixed nitrogen in an alfalfa crop following its spring plow-down was not effectively utilized by the rotational bean crop, but was effectively utilized by rotational field corn.

Factors Impacting Water Quality		
	RISK CATEGORY	MITIGATING PRACTICES
Soil Test P	Low	Soil test P is in the low range for most crops. Recommendation: Use and follow crop-specific U of I Fertilizer Guides.
P Fertilizer Rate	Medium	Increased P application rate increases the risk of off-site transport. REQUIRED: Use and follow crop-specific U of I Fertilizer Guides.
P Fertilizer Method	Medium	REQUIRED: place commercial fertilizer P with planter, or inject > 2", or incorporate immediately after broadcasting.
P Organic Rate	Very Low	No animal waste applied
P Organic Method	Very Low	No animal waste applied
N Fertilizer Rate	Very High	Increased potential for off-site nitrogen transport. REQUIRED: Follow the 590 standard.
N Fertilizer Timing	Low	Proper nitrogen application timing. Recommendation: Follow N application rate recommendations and apply according to crop growth needs.
N Fertilizer Method	High	REQUIRED: place commercial fertilizer N with planter, or inject > 2", or incorporate immediately after broadcasting.
Runoff Class	Very Low	Little surface runoff occurs from storm events. Low risk of soluble and/or sediment-attached nutrient loss.
Irrigation Runoff Index	Low	Little surface runoff occurs from irrigation. Low risk of soluble and/or sediment-attached nutrient loss.
Runoff BMPs (level of use, not risk)	None Used	REQUIRED if runoff occurs: Apply in-field conservation practices that reduce soil erosion and runoff. Conservation practices that trap and/or filter nutrients are also required.
Irrigation Index (for deep percolation)	Medium	Potential for leaching of nutrients exists. REQUIRED: Use IWM (449).
Leaching Index (non-growing season risk)	Very Low	Lower potential for leaching during the non-growing season.
Distance	Very Low	Increased distance to surface water reduces transport risk.
Soil Properties	Very High	Soil properties and proximity of water table to surface increases groundwater vulnerability. REQUIRED: Use proper nutrient timing/form, and IWM.
Soil Erosion	Very Low	No erosion occurs.
Total Points for Surface Water:	15.00	< These numbers are a product of the rating and the weighting factor.
Total Points for Ground Water:	19.75	
Overall Risk Level for Surface Water Quality:	MEDIUM	If Risk Level is not LOW, then appropriate mitigating practices are required in order to meet Quality Criteria for Surface Water Quality and/or Ground Water Quality. Conservation practices and management techniques need to be incorporated into planning alternatives in order to address source and transport problems. Nutrient Management (590) and Irrigation Water Management (449) (if irrigated) are MANDATORY mitigating practices. Additional required practices are indicated above for individual factors.
Overall Risk Level for Ground Water Quality:	HIGH	

Table 16. IDAHO NUTRIENT TRANSPORT RISK ASSESSMENT (INTRA) on Fort Hall Indian Reservation, Field #2, Site 2-4, based on data from the WQIP POLLUTION PREVENTION REPORT. INTRA illustrates a HIGH ground water environmental risk associated with the potential loss of nitrate-N from the productive root zone.

Drainage Systems

The main drainage systems in the area include the Fort Hall Main Canal, Gibson Canal, Marlow Lateral and Gibson Drain. The Fort Hall Main Canal is the principal delivery system for surface irrigation water to the Zone 1 area. It is unknown whether water conveyed through the above-mentioned systems has been sampled for the presence of nutrients or other contaminants. It should be noted that tile drains exist which drain to the bottomlands, potentially impacting surface water as well.

It is not known if the drainage systems identified above are a potential ground water risk. Combined with the fact that the canals are not lined and are estimated to leach water at a rate of 10 to 20 percent of their flow, water quality grab samples were previously listed as a recommended immediate action. This will help determine the potential source of ground water pollution from the canal and drain water.

Critical Areas

Critical areas are areas or operations which contribute the most to nitrate contamination of the ground water resource. The following were identified as critical areas in the project area (which includes Zone 1, 2 and 3):

85,000 acres of irrigated crop land on 0 to 10 percent slopes, including rotations with row crops such as potatoes on sandy to loamy soils with moderate to rapid permeability, well to excessively drained soils, and those soils that contain coarse gravelly material at 20 to 40 inches.

POTENTIAL ALTERNATIVE SOLUTIONS

Introduction

Although the project area has a variety of resource problems, the scope of the project is focused on ground water quality impacted from current agricultural sources. For that reason, only irrigated crop land is addressed in this study and only alternatives and recommendations that address ground water quality on irrigated crop land in critical areas have been considered.

Alternatives Considered (Alternatives 2 – 5 are not mutually exclusive)

Alternative 1 - No Action - Future Without Project

This alternative does not meet the objectives of the Sponsors. The group felt that it is important to proceed with implementation as soon as possible in order to maintain present momentum and to build on the recent successes within the project area. At the present time, the only ongoing programs that affect the degree of ground water protection are the EPA 319 Non-Point Source Program (NPSP) and the NRCS Environmental Quality Incentive Program (EQIP). This status quo alternative supposes no further changes to agricultural systems or explorations of possible new agronomic systems.

Alternative 2 – Land Treatment of All Critical Irrigated Crop Land Acres

Alternative 2 treats the resource problems by installing and maintaining resource management systems. This alternative comprises a combination of management practices such as conservation cropping sequence, nutrient management, irrigation water management, integrated pest management and residue management. In order to improve ground water quality, these practices must be applied in a manner tailored to local conditions. Participation can be voluntary or required. Standards can be specific or general. Also, the guidance available to implement these practices in the project area could vary from none to a full-time agricultural consultant focused on the goal of improving ground water quality, as opposed to maximizing yields or fertilizer sales.

Alternative 2 might involve a different cropping system, perhaps including nematode-suppressing crops, such as mustard, radishes and rapeseed/canola in lieu of pesticides. It might also involve crop rotation changes with addition of deep rooted crops, such as corn, sunflower, and again rapeseed/canola. These crops would be grown to utilize carryover nitrogen following the potato crop. This alternative may ultimately involve alternative markets, crops and cropping systems. However, testing would be necessary to develop viable alternative systems.

Alternative 3 – Ground Water Quality Mitigation

Alternative 3 would establish shallow irrigation wells with the purpose of initial dewatering of the perched water table. The system might utilize tile drains positioned at the interface between the surface soils and the gravelly subsoils. This alternative would physically mine (remove) the contaminated ground water from below the crop land utilizing pumping stations. Future recharge from irrigation systems and other “clean” sources would need to be controlled so that the aquifer would not be re-contaminated. This mitigation technique has been utilized in other states, and the concept would need complete evaluation of positive and negative impacts.

Alternative 4 – Centralized Automated Irrigation Water Management

Alternative 4 would utilize a centralized automated system to inform landowners/operators when to irrigate. The system would utilize in-field moisture monitors established as a network on selected soils and fields. The data collected from the monitors would be transmitted via a FM signal to a central and/or individual locations. Critical periods would be monitored to track moisture availability and could be utilized by the growers to time irrigation start-up, irrigation frequency and application rate and irrigation turn-off. Irrigation start-up and turn-off timing would be utilized to minimize moisture movement during the spring and fall when ET rates are at the lowest for the growing season.

Alternative 5 – Expand the Zone 1 Soil Survey

The original Fort Hall Soil Survey that was completed in 1963 and published in 1977 (SCS, 1977) has been shown to be seriously out of date. The soils mapping of Zone 1 that was conducted in 1995 demonstrated that the original soil survey was not done with sufficient detail for the existing landuse (refer to Appendix, Maps 2 to 7), and the entire cropped area of the Reservation should be remapped.

Discussion and Evaluation of Alternatives

It is clear that the project area does not need the typical package of land treatment practices on crop land. Sprinkler systems are already in place. Future improvements in water quality related to agriculture will need to come from non-structural management practices such as nutrient and pest management, irrigation water management, changes in crop rotations, and the implementation of newer technologies.

In the years that have passed since the NRCS Preliminary Investigation Report, much work has been done studying ground water quality and its relationship to local agriculture. Standards for wells were created. A community water supply system has been provided for those landowners with water quality-impacted domestic wells. WQIP contracts and agronomic studies showed that potatoes can be grown successfully with a maximum of 350 pounds of nitrogen and irrigation water application limited to 10% above crop water demand. A new Agrimet station was installed on the Reservation to accurately measure ET and other weather parameters. Despite all this progress, a giant leap forward in cropping management systems seems to be required to minimize the risk of further agricultural pollution of ground water. Grants are being written to experiment with alternative (possibly organic) cropping of potatoes and other crops on the Reservation. The arrival of early blight and deeply depressed potato prices created concern about the future of potato cropping on the Reservation. The income from crop land leases has been important and would be difficult to replace.

Apart from ground water concerns on crop land (the major resource concern), there are opportunities for improvements in resource management systems in several other areas. Wind erosion and crop damage from saltation of wind blown sand grains are resource problems that can be addressed through windbreaks, tillage and residue management systems.

Alternative 1, “no action” to improve ground water quality, is in conflict with the Shoshone-Bannock Tribes’ commitment to insuring a high quality environment on the Reservation for the benefit of future generations. Also, the “no action” alternative is not an acceptable alternative in light of EPA regulations, especially considering the “Sole Source” status of the Snake River Plain Aquifer.

Alternative 2 could involve a broad spectrum of practices or perhaps enforcement of the best management guidelines already adopted by the Tribes as a conditional requirement of crop land leases in the project area. For example, integrated pest management might be merely “scout and spray” or it might include the use of biological pest controls. Similarly, irrigation water management might include merely rebuilding worn sprinkler heads or it might involve intensive soil water monitoring in the potato year. It might also include replacing inefficient end guns with solid set or drip irrigation on pivot corners. Nutrient management can involve a prescribed soil sampling routine with limits on total nitrogen fertilizer applied (the present guidelines) or it could involve techniques such as the use of organically-complexed fertilizers, foliar and precision application systems. The journey into leading-edge technologies may be inevitable to combat the extreme vulnerability of the ground water resource. The Tribal government and the Conservation District will probably need to be resourceful and creative in the development of alternative crops and finding new markets.

Alternative 2 could also include a lengthening of the typical potato rotation either with additional grain years or the addition of a new rest or pest management crop. More conventional approaches would include the addition of extra grain years or alfalfa hay in the rotation.

Alternative 3 would involve the development of an irrigation drainage district. Although the intent initially involves the reduction of a perched water table, the ultimate goal would be to intercept and manage the water that is the source of the high water table. The ultimate objective is to prevent a direct ground water interface with potentially contaminated surface-applied waters. While this would not benefit the current EDB contaminated portions of the deeper aquifer, it would prevent further contamination and remediate this shallow ground water source.

A detailed examination of the perched aquifer would be required, to include source, geological boundary, and potential for impact from surface/near-surface contaminants. This assessment would evaluate the impact from off-site sources, identify underground features that impact flow velocity and volume, and determine if and where the perched water table is impacting the deeper aquifer (“bathtub” effect). The depths to which potentially contaminated surface-applied waters impact the aquifer would be examined and used to manage recharge and prevent recontamination. A strategy would then be developed to “dewater” areas where well tests indicate high nitrate levels. Ideally, an analysis would compare the costs and impact for development of a basin recharge program vs. the development of regionalized domestic water systems utilizing ground water sources not impacted by nitrates or other contaminants (or surface-water supplied systems).

Alternative 4 would develop a state-of-the-art irrigation water management system. The system would involve the development of a soil moisture monitoring system. The project area would be divided into monitoring zones based on soil types, water table levels, and the presence of gravelly subsoils. The data from each monitoring site would be transmitted via FM to a centralized site for planning and scheduling purposes. Each site could be monitored by the grower for development and management of each field’s irrigation schedule.

PAGE LEFT INTENTIONALLY BLANK

CONCLUSIONS and RECOMMENDATIONS

Conclusions

Ground water quality sampling has demonstrated past water quality degradation and continuing problems with nitrates and pesticides (and other volatile chemicals) in area wells. Of particular concern is the lack of improvement in nitrate levels over the past 15 years in the Fort Hall Nitrate Priority Area, and the continued detections of currently applied pesticides.

The following recommendations have been developed to address the ongoing ground water quality problems in the project area related to agriculture.

Recommendations

1. Recommend expanding the Zone 1 Soil Survey to include the entire project area or remapping the entire Fort Hall Indian Reservation.
2. Recommend implementation of Alternative 2 - land treatment of all critical irrigated crop land areas utilizing all available programs.
3. Recommend that the Tribes revise or develop new agricultural leases on the Reservation which contains language that requires the Lease Holders to develop and maintain a conservation plan with the NRCS and the NRCD including:
 1. Nutrient Management Plan,
 2. Irrigation Water Management Plan,
 3. Pest Management Plan.
4. Recommend that the Tribes consider changes to the current crop rotations by including rotational crops following potatoes based on their ability to utilize carryover nitrogen and to uptake nutrients from below the potato rooting depth. In addition it would be desirable that the rotational crop be a late nitrogen feeder to utilize the carryover nitrogen that is contained in the vines of the potato crop.
5. Recommend that the lease holders utilize and are equipped with the latest IWM Technology, including meters and moisture sensors as discussed below.
6. Recommend that the Tribes require Lease Holders to utilize the following Nutrient and IPM management strategies (as discussed below).
7. Recommend that the Tribes continue with water quality monitoring (as discussed below).

High Level of Nutrient Management

Nutrient management planning (NMP) is the process of determining and managing the amount, source, placement, form, and timing of the application of nutrients and soil amendments. It is intended that nutrient management plans be developed to assist the producers in improving or maintaining their level of management and expertise as it relates to the application of nutrients

on the lands they own and/or control. The intent of a Nutrient Management Plan is:

- To budget and supply nutrients for plant production.
- To properly utilize manure or organic by-products as a plant nutrient source.
- To minimize agricultural nonpoint source pollution of surface and ground water resources.
- To protect air quality by reducing nitrogen emissions (ammonium and NO_x compounds) and the formation of atmospheric particulates.
- To maintain or improve the physical, chemical and biological condition of soil.
- To prevent or reduce excess nutrient concentrations in the soil.

A part of the NMP is the development of the nutrient management budget for nitrogen (N), phosphorus (P), and potassium (K) that will consider all potential sources of nutrients. These sources include, but are not limited to, animal waste, composted animal waste, other composted by-products, organic by-products, waste water, commercial fertilizer, crop residues, legume credits, and irrigation water. When nutrients are applied on an annual basis, annual soil samples shall be taken and an annual nutrient budget developed.

The annual nutrient budget is developed from realistic yield goals based on soil productivity information, historical yield data, climatic conditions, level of management and/or local research on similar soils, cropping systems, and soil and manure/organic by-products tests. Once the realistic yield goal is established, then the NMP will specify the source, amount, timing and method of application of nutrients on each field to achieve the realistic production goals, while minimizing movement of nutrients and other potential contaminants to surface and/or ground waters.

The project area is characterized by having high nitrate in its ground water. Current nutrient management (nitrogen) suggests that the potential of high carryover nitrogen application in the potato crop could be a major contributor to ground water nitrate. The implementation of a NMP for each field that includes potatoes as part of its rotation has the potential of reducing the nitrate loading to ground water.

High Level of Irrigation Water Management

Irrigation water management (IWM) is the process of determining and controlling the volume, frequency, and application rate of irrigation water in a planned, efficient manner. IWM requires knowledge, skills and the desire to determine when irrigation water should be applied. The main factors influencing IWM are *irrigation interval* (time between irrigations), *irrigation set time* (time water is applied) and *application rate* (rate at which water is applied). These parameters define the timing and duration of irrigation and the amount of water applied. System design and maintenance are also important factors influencing IWM.

The ground water resource problems within the project area can be partially attributed to irrigation systems and management of those systems. Over-irrigation leads to deep percolation and translocation of mobile nutrients, like nitrate, and certain pesticides below the root zone. Impacts are exacerbated by the high water table and coarse soils in the Gibson Terrace area. Ten to thirty-five percent of the applied water is deep percolated.

Crop land within vulnerable aquifers requires a commitment to irrigation water management to protect ground water quality. Ideally, a sound management plan will only replenish the active

roots thereby conserving water and reducing potential leaching of nitrates and pesticides. Soil moisture sensors, if used properly, can facilitate irrigation management, conserve water, and prevent excessive chemical leaching. Some producers may already be using soil moisture monitoring tools such as tensiometers, gypsum blocks, or granular matrix sensors (like Watermark soil moisture sensors) for irrigation scheduling, but most producers monitor soil moisture with a shovel and some version of a “feel and appearance” method.

Determining when to irrigate and how much water to apply are not simple tasks. The decision of when to irrigate is usually based on past experiences or weather-based information (crop evapotranspiration data). Past experiences may not be applicable and are often not adjusted for annual changes in weather. Even with years of experience, it is very difficult to consistently irrigate at the best time and with the ideal amount of water. Soil moisture monitoring is a relatively simple and effective method for managing irrigation water, and can be easier and more practical than many other irrigation scheduling techniques.

Soil moisture monitoring is helpful to verify that current irrigation practices satisfy, but do not exceed, the needs of the crop. This is critical to reducing impacts to ground water quality from nutrients and pesticides. A graph of soil moisture readings over the season provides a sound basis for altering and fine-tuning irrigation practices. The principle behind irrigation management is to irrigate only enough to meet crop needs. Soil moisture sensors improve the chances of making the right irrigation decisions.

Successful implementation of irrigation water management through soil moisture monitoring requires careful attention to the installation, operation, and maintenance requirements. Utilizing soil moisture monitoring successfully requires hands-on learning and technical assistance from the manufacturer, Extension or crop advisors familiar with the product. Soil type and irrigation regime are important parameters affecting the choice of a method or technique which will yield the best results. A routine sampling schedule should be implemented to obtain the most information. Soil water should be measured or monitored in at least two depths in the expected crop root zone at several locations in a field to obtain a field average.

Integrated Pest Management Strategies

The NRCS Pest Management Standard should be used wherever pests (insects, weeds, diseases, etc.) are managed. The Pest Management Standard (595) involves an environmental impact analysis of all pesticides currently used. Any pesticides that rank INTERMEDIATE or higher for either human or aquatic hazard will need to be mitigated. Mitigating practices are dependent on the off-site transport mechanism(s) (e.g. leaching) and on the specific site conditions. Irrigation water management is an important mitigating practice for irrigated lands. Additional mitigating practices can include both management and structural practices that address erosion control, runoff, and/or leaching. A number of pesticides currently used in the project area have leaching risk and/or have been detected in ground water. Practices other than IWM that mitigate for leaching include crop rotation, residue management, and pasture and hay planting. The over-riding principle of the 595 standard is Integrated Pest Management (IPM). IPM plans should be developed in conjunction with mitigating practices to reduce pesticide risk to ground and surface water. The Potato Growers of Idaho (PGI) have developed a best management practices checklist for potato producers. This checklist identifies practices to reduce the use and/or risk of pesticides and addresses water quality concerns, and is a good basis for an IPM approach. The use of Integrated Pest Management is an essential practice to reduce the risk of pesticides to water quality, especially in vulnerable or sensitive areas.

Guidelines for the development of an IPM plan can be found at http://www.id.nrcs.usda.gov/technical/guidance_ipm.html.

Elements of Integrated Pest Management

- **Prevention** is the practice of keeping a pest population from infesting a crop or field, and should be the first line of defense. It includes such tactics as using pest – free seeds and transplants, preventing weeds from reproducing, and cleaning tillage and harvesting equipment between fields or operations
- **Avoidance** tactics, such as cultural practices, can reduce the impact when pest populations exist in a field or site. Examples of avoidance tactics include crop rotation, choosing cultivars with genetic resistance to pests, and using trap crops or pheromone traps.
- **Monitoring** activities such as scouting and pest forecasting that can help to determine if and when suppression activities are needed, or to determine if a particular pest control strategy is working or not.
- **Suppression** may become necessary to avoid economic loss if prevention and avoidance tactics are not successful. Pesticides are typically used to suppress pest populations. However, non-chemical suppression tactics may include cultural practices, physical suppression, and biological controls.

Implementation of IPM

Field scouting uses different techniques to classify the status of a pest population for decision-making purposes. Field scouting procedures are available for many of the major pests in Idaho. If no specific guidance is available, field sampling should be done randomly, with samples taken from across the entire field. Take at least 5 samples and preferably 25 – 30 samples per field.

Pest forecasting uses information or data to predict pest problems early. Regional pest monitoring systems can complement scouting. Idaho's BEACON program, for instance, uses a regional monitoring network of insect traps that provides bean and sweet corn growers advanced warning of damage expected from the western bean cutworm. PNW Pest Alert system also provides current information on pest problems in the region. In addition, models have been developed, like the degree-day approach, which can help determine when scouting should begin, or when pesticide application will have the maximum control.

For major insect pests in Idaho, guidelines have been developed that help identify when pesticide use is, and is not, necessary. This **economic threshold** is based on the cost of the control action vs. the cost of the yield loss that pest populations would inflict on the crop without control. It is also referred to as the action threshold. Control action is needed once this level is reached to prevent the pest population from increasing to a point where economic injury will occur. Established thresholds for many insect pests can be found on the University of Idaho Pest Management website, http://www.ag.uidaho.edu/pmc/pest_management.htm (select a specific crop for pest information).

Chemicals released into the environment may have a variety of adverse ecological effects, and use of pesticides can negatively impact humans and non-target plant and animals, and degrade

water quality. Selection of pesticides that pose the least risk of off-site transport and hazard to non-target species should be used whenever and wherever possible.

The Environmental Protection Agency has developed a listing of “Reduced Risk” pesticides. EPA gives priority in its registration program for conventional chemical pesticides to pesticides that meet reduced risk criteria: low-impact on human health, low toxicity to non-target organisms (birds, fish, and plants), low potential for ground water contamination, lower use rates, low pest resistance potential, and compatibility with Integrated Pest Management.

The use of non-chemical strategies to avoid, prevent or suppress pest populations is a key element of IPM. One example of this strategy is green manure cover crops. Green manure cover crops, such as oil radish and mustard, have been successfully used in crop rotations before sugarbeets, potatoes, onions, beans, and other row crops. Green manure crops can improve soil quality, fertility and water infiltration, and suppress soil-borne pests and diseases. Reductions in the numbers of nematodes, disease problems, and weeds are thought to be due in part to the presence of glucosinolates in green manure crops. When the crop is incorporated into the soil, the breakdown of glucosinolates produces other chemicals that act against pests. These chemicals are similar to the active chemical (methyl-isothiocyanate) produced by soil application of a synthetic fumigant, like metham sodium (from *Using Green Manures in Potato Cropping Systems, Washington State University Extension Bulletin, EB1951E*).

The use of mustard green manures in potato cropping systems has been successfully demonstrated on the Fort Hall Indian Reservation in a cooperative study funded by Western-SARE (2003). In field trials, the potato crop after mustard green manure incorporation performed as well as the standard treatment with methyl-isothiocyanate releasing products (such as metam-sodium). Mustard production costs averaged \$120/acre/year over the 2-year trial (Three Rivers RC&D 2005).

Careful management is needed to realize the full benefits of green manure crops. For potato cropping systems, approximately 15 lbs/acre of mustard seed is planted in mid-August following a grain or bean crop. Planting time is important to achieve optimal green manure crop production. Poor field preparation can hinder germination and growth. Demonstration studies have shown that irrigation, fertilization, and/or weed control are required, but amount of nitrogen and water applied should be carefully monitored. After approximately 8-10 weeks of growth, the green manure crop is chopped and disked. Research on green manure crops is on-going by the University of Idaho – Aberdeen Research and Extension Center (in cooperation with the Tribes), and the Agricultural Research Service-Northwest Irrigation and Soils Research Laboratory.

Specific recommendations for IPM practices, by crop, are available on the University of Idaho's Pest Management website: <http://www.ag.uidaho.edu/ipm/Pests/cropPests.htm>.

Safe Handling and Disposal of Pesticides and Pesticide Containers

The single most important approach to pesticide safety is to read the pesticide label before each use and follow the directions. The label provides all the information needed to safely handle and dispose of the pesticide and the container. If still in doubt after reading the label, contact a person qualified to help in evaluating the hazard of the chemical and its use. Proper use and disposal of pesticides and pesticide containers is essential to prevent contamination of ground and surface waters.

Selection and Use

Select pesticides and application methods carefully. Before choosing a pesticide, review the product label for ground and surface water advisories and pay specific attention to the environmental hazards section. Avoid applying pesticides in weather conditions where drift or runoff may occur, and properly adjust the application equipment to minimize non-target exposure. Ideally, buffers or setbacks should be used around sensitive areas or water bodies. Use spot applications rather than broadcast applications when applicable. Proper calibration of equipment also reduces risk of non-target exposure and assures proper application rates. Application equipment should be calibrated at least seasonally. Avoid mixing and loading pesticides near wells and other water sources. Prevent back-siphoning and spills from occurring.

Review your process for using, transporting, and storing pesticides to identify areas for additional training or precautions. Know the necessary actions to take if a spill should occur. Prior training on how to limit a spill and then safely clean it up is invaluable. Accidents most commonly happen when pesticides are being transported or when pesticide containers have leaked in storage. Pesticide spills require immediate action. Keep a spill cleanup kit immediately available at all locations where pesticides are handled, transported, or stored because you will not have time to locate all the necessary items before a significant amount of contamination has occurred. Stopping large leaks or spills is often not simple. If you cannot manage a spill by yourself, get help. Even a spill that appears to be minor can endanger you, other people, and the environment if not handled correctly.

Disposal of Containers

Unrinsed or contaminated “empty” pesticide containers, unless they are accepted by a pesticide distributor or manufacturer for refilling, are considered **hazardous waste**. Hazardous waste is more difficult and more expensive to dispose of. Therefore, to avoid added costs and potential harm to the environment, it is desirable to clean the containers. Clean, dry containers are considered solid waste and can be disposed of in a state-permitted solid waste site. Clean, dry containers may also be recycled.

Before agricultural pesticide containers can be accepted for disposal or recycling, they must be thoroughly rinsed of all residues immediately after use. Only dry, properly rinsed containers are accepted at collection sites. Properly rinsing and handling empty pesticide containers is very important, because it:

- Protects humans by removing hazardous materials.
- Prevents sources of environmental contamination.
- Saves money by putting all product into the spray tank.

Unrinsed pesticide containers can still hold enough material to harm people and the environment.

Disposing of Unused Agricultural and Household Pesticides

ISDA conducts unusable pesticide disposal collection from agricultural producers, dealers, homeowners and applicators throughout the state. Prospective participants need only bring their unusable pesticides to the most convenient collection site listed on the “Pesticide Disposal Program Schedule.” This program provides the agricultural producer and homeowner a safe, convenient, and environmentally friendly way to dispose of unusable pesticides. This program is free for the first 1,000 pounds of unusable pesticides per participant. For more information and current schedules, contact ISDA at 208-332-8500, or visit their website: <http://www.agri.state.id.us/Categories/Pesticides/pdp/indexdisposalmain.php>.

In addition, many local communities provide household hazardous waste collection sites. The Shoshone-Bannock Tribes may want to consider organizing their own pesticide disposal and/or pesticide container recycling program.

Continued Water Quality Monitoring

According to the Idaho Ground Water Quality Plan (GWQC 1996), IDWR is responsible for the statewide ground water quality monitoring program, and has performed limited well monitoring in the project area since 1991. Where land use activities contributing to degraded ground water quality involve agricultural practices, ISDA provides monitoring and assessment, and have monitored wells-off Reservation in the vicinity of the project area. This ISDA regional water quality project ended several years ago. The Shoshone-Bannock Tribes have a Water Resources Department and a Water Quality section, operating under the direction of the Tribal Water Resources Commission. The Tribes have an on-going water quality monitoring program.

Concerns for the project area include:

- the current nitrate levels in project area wells, particularly in the Gibson Terrace area, have not shown any decreasing trends over the past 15 years, and some individual wells have shown an increasing trend,
- pesticide detections within the project area to date, some of which pose a high hazard to humans and non-target species, and
- the potential for future water quality problems from the current soil fumigants used on the Reservation.

Because of these concerns, NRCS recommends an extensive, continuous monitoring effort designed to evaluate future conditions and determine whether conservation practices are providing the required impact. The Tribes may already have this network set up, or may need to expand on current monitoring efforts. The need to monitor for pesticides as well as other water quality constituents is very important. Coordination between the Tribes and the Idaho Department of Agriculture may benefit data collection efforts. The ISDA often has discretionary funds provided by EPA for pesticide sampling, and their sampling efforts may complement or supplement the Tribes’ water quality data.

PAGE LEFT INTENTIONALLY BLANK

POTENTIAL SOURCES OF FUNDING

The following are potential sources of technical and financial assistance for planning and implementation that the Fort Hall NRCDC would be eligible to pursue in addressing the identified problems associated within the Fort Hall Project Area. Some funding sources are for individuals, while others are oriented towards working with groups of individuals on a project action basis. Some funding sources apply only to public lands; others only to private lands.

Conventional Bank Loans

Many structural practices can be funded by conventional bank loans.

Conservation of Private Grazing Land (GLCI)

The 2002 Farm Bill established a grazing lands provision to ensure technical, educational and related assistance is provided to landowners on the nation's 642 million acres of private grazing lands. NRCS is the lead agency to implement GLCI.

Environmental Protection Agency (EPA) Indian General Assistance Program

It is EPA policy to work with Tribes on a government-to-government basis to enhance environmental protection in Indian Country and tribal communities. In 1992, Congress passed the Indian Environmental General Assistance Program Act which authorizes EPA to provide General Assistance Program (GAP) grants to federally-recognized Tribes and tribal consortia for planning, developing, and establishing environmental protection programs in Indian Country, as well as developing and implementing solid and hazardous waste programs on tribal lands. The goal of this program is to assist Tribes in developing the capacity to manage their own environmental protection programs, and to develop and implement solid and hazardous waste programs in accordance with individual tribal needs and applicable federal laws and regulations.

EPA Non-Point Source Pollution Program (CWA 319)

The CWA 319 Program provides financial assistance to Tribes to assist in the implementation of EPA approved Nonpoint Source (NPS) Management Programs or the implementation of individual nonpoint source projects. Projects funded must be related to implementing non-point source controls that can include: Watershed Restoration Projects, Ground water Assessment Projects, Development and Implementation of Farm Plans, Monitoring and Information Gathering, and Staff Support. There are two avenues by which a tribe can receive Clean Water Act Section 319 funds: directly from EPA after receiving "treatment as a state" (TAS) status or by applying to the lead state water quality agency for pass-through funds from its Section 319 allocation.

EPA Water Pollution Control Program (CWA 106)

The CWA 106 Program provides assistance for developing and implementing water pollution control or ground water protection programs on Indian Reservations. Activities include identification/assessment of water pollution sources and impacts, development of comprehensive water resources management plans for these sources, water quality monitoring/water data development, establishment of tribal water quality standards/ordinances/regulations, delineation of aquifer protection zones for ground water protection measures.

Environmental Quality Incentives Program

The Environmental Quality Incentives Program (EQIP) was established by the 2002 Farm Bill. In Idaho, EQIP combines the functions of the Agricultural Conservation Program and the Water Quality Incentives Program. The NRCS is the lead agency to implement EQIP. EQIP gives higher priority to areas where agricultural improvements will help meet water quality objectives.

EQIP provides 1 to 10-year contracts for technical assistance and up to 75 percent cost-share of conservation practices for the treatment of resource problems for all agricultural land uses, riparian areas and water quality improvements. EQIP requires activities under a contract to be carried out according to a conservation plan. Land eligible for EQIP includes agricultural land that poses a serious problem to soil, water or related resources.

Habitat Improvement Program (HIP)

This program, administered by the Idaho Department of Fish and Game (IDFG), provides cost-share, primarily to landowners, for the development and improvement of wildlife habitat for both upland game birds and waterfowl.

Idaho Department of Water Resources (IDWR)

IDWR authorizes the state to make loans and/or grants for water resource projects that conserve and protect ground water and are in the public interest. There is a Revolving Development Fund for low interest loans on construction-related projects to local governments, irrigation companies, NRCDs and Water Users Associations. There is \$500,000 maximum with a 10-15 year payback period. There is also a Water Management Loan/Grant Program, which can be set up as a match grant or as a loan. The maximum amount is \$50,000, but typical amounts are between \$5,000 and \$10,000. It can be used for preliminary engineering studies or for construction projects, but it must be for water quality.

NRCS Assistance to Conservation Districts - Public Law 46

Under the authorities of this program, the USDA Natural Resources Conservation Service, through local Soil Conservation Districts or Natural Resource Conservation Districts, assists both individuals and groups in the planning and application of needed soil and water conservation practices on private land. The amount and timing of this technical assistance is determined and prioritized by the NRCS Field Office, and the Fort Hall Natural Resources Conservation District. This assistance is typically referred to as the Conservation Operations Program

Resource Conservation and Development (RC&D)

Fort Hall Indian Reservation is located within the Three Rivers RC&D Area. Technical assistance is available through the Three Rivers RC&D Coordinator to identify and secure potential funding.

US Fish and Wildlife Service (USFWS) Partners Program

This program, administered by the USFWS, provides cost-share incentives to landowners for the restoration and protection of wetland and riparian habitats. This program could be used to enhance wetlands in the Project area.

Watershed Protection and Flood Prevention Act (Public Law 83-566)

The P.L. 566 program is administered by the USDA NRCS. PL-566 provides both technical and financial assistance for the protection of watershed areas through the establishment of land treatment measures to reduce off-site damages which degrade surface and ground water quality, impair fish and wildlife (especially threatened and endangered species) and degrade municipal works of improvement. Cost-share rates are typically 65 percent.

Wetlands Reserve Program and Conservation Reserve Program

The WRP and CRP provide landowners with options for protecting wetlands and highly erodible lands. In the Wetlands Reserve Program, landowners can choose either permanent or 30-year easements or restoration only cost-share agreements. The NRCS is the lead agency for this program. The CRP protects highly erodible and environmentally sensitive lands with grass, trees and other long-term cover. New enrollments can replace expired or terminated contracts as well as new acreages. The Farm Service Agency (FSA) is the lead agency for the CRP.

Wildlife Habitat Incentives Program

This provision of the 2002 Farm Bill will provide technical assistance to landowners to improve wildlife habitat on private lands. The program will provide cost-share to landowners for developing habitat for upland wildlife, wetland wildlife, endangered species and fisheries. The NRCS is the lead agency to implement the program and will consult with the State Technical Committee to set priorities for cost-share measures and habitat development projects.

PAGE LEFT INTENTIONALLY BLANK

REFERENCES

- DeJongh, L. 1996. Observations of ethylene dibromide occurrence on the Fort Hall Indian Reservation. Shoshone-Bannock Tribes.
- Dow, D.C. 1978. Shoshone-Bannock Tribes – Gibson Irrigation Wells. Robinson and Noble, Inc. Tacoma, WA.
- EPA. 2001. Source water protection: Best management practices and other measures for protecting drinking water supplies. Environmental Protection Agency, Drinking Water Academy, Training Course, August 2001, Boise, Idaho.
- EPA. 2004a. Drinking water standards website (<http://www.epa.gov/safewater/mcl.html#mcls>).
- EPA. 2004b. Envirofacts data warehouse (http://www.epa.gov/enviro/index_java.html and <http://oaspub.epa.gov/tims/twe.html>).
- EPA 2005. Drinking water quality in Indian country: protecting your sources. US Environmental Protection Agency 816-F-05-011.
- Focazio, MJ, TE Reilly, MG Rupert, and DR Helsel. 2002. Assessing the ground-water vulnerability to contamination: Providing scientifically defensible information for decision makers. USGS Circular 1224.
- Garabedian, S.P. 1986. Application of a parameter-estimation technique to model the regional aquifer underlying the eastern Snake River Plain, Idaho. U.S. Geological Survey Water Supply Paper 2278.
- GWQC (Ground Water Quality Council). 1996. Idaho Ground Water Quality Plan. Idaho Department of Health and Welfare Division of Environmental Quality, Idaho Department of Water Resources, and Idaho Department of Agriculture. 176 pp.
- Hagan, E. 2004. Summary of year 2003 detections of concern, Statewide Ambient Ground Water Quality Monitoring Program. Idaho Department of Water Resources. <http://www.idwr.idaho.gov/hydrologic/info/pubs/gwq/MCLsummary2003.pdf>
- IASCD. 2006. Blackfoot River TMDL Agricultural Implementation Plan http://www.deq.state.id.us/water/data_reports/surface_water/tmdls/blackfoot_river/blackfoot_river_implementation_sec1.pdf
- IDEQ. 1999. Idaho Source Water Assessment Plan. Idaho Division of Environmental Quality, Ground Water Program. October 1999.
- IDEQ. 2001a. State of the environment. Idaho Department of Environmental Quality.
- IDEQ. 2001b. Portneuf River Subbasin Assessment and TMDL http://www.deq.state.id.us/water/data_reports/surface_water/tmdls/portneuf_river/portneuf_river.cfm
- IDEQ. 2002a. DEQ's final nitrate priority area ranking. (<http://www.deq.state.id.us/water/gw/nitrate.FinalRank.pdf>).

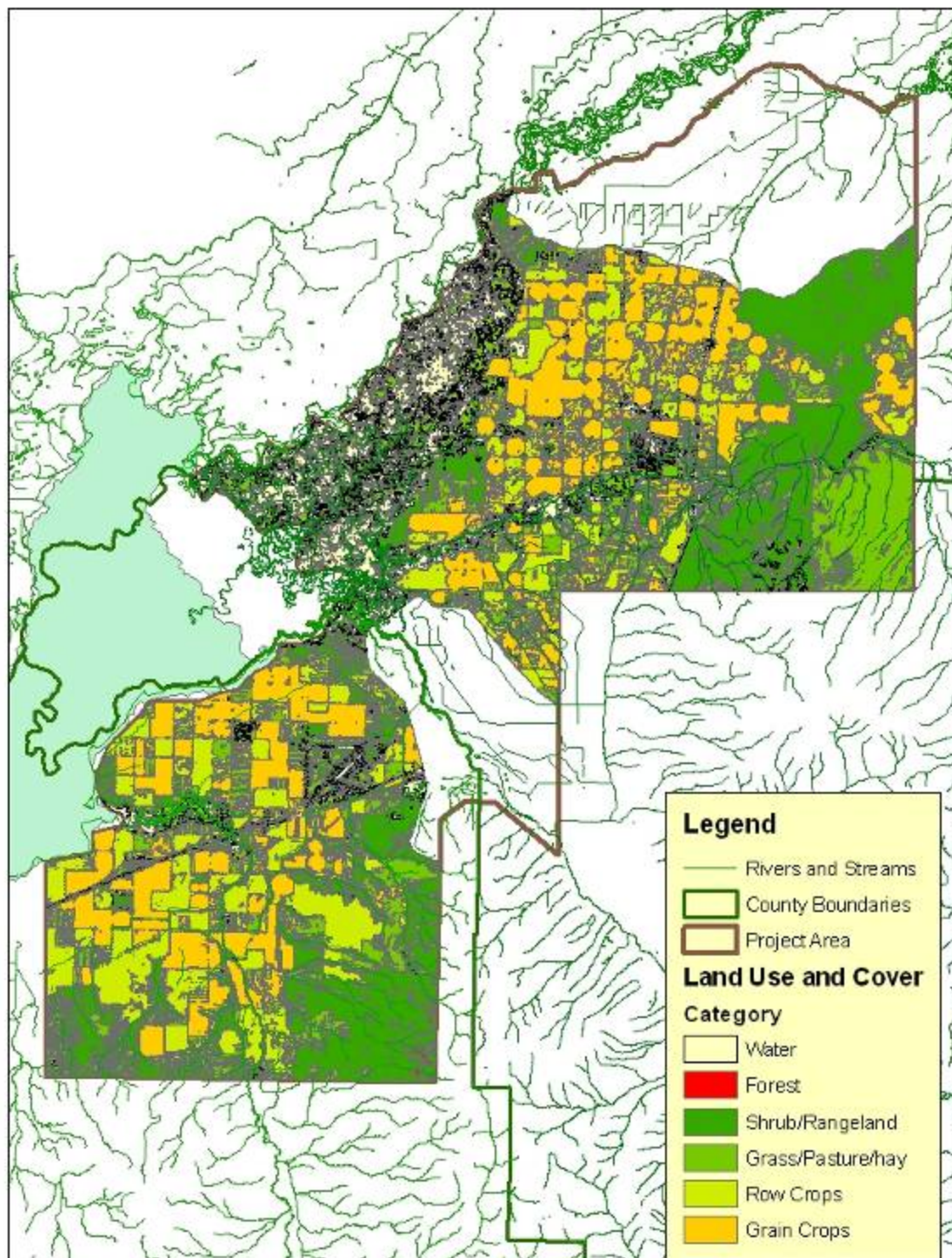
- IDEQ. 2002b. Blackfoot River Subbasin Assessment and TMDL
http://www.deq.state.id.us/water/data_reports/surface_water/tmdls/blackfoot_river/blackfoot_river.cfm
- IDEQ. 2004. American Falls Subbasin Assessment and TMDL (Draft).
http://www.deq.state.id.us/water/data_reports/surface_water/tmdls/american_falls/american_falls.cfm
- IDEQ 2006a. 2002 Integrated Report (approved December 2005).
http://www.deq.idaho.gov/water/data_reports/surface_water/monitoring/integrated_report.cfm
- IDEQ. 2006b. American Falls Subbasin Assessment and TMDL (Revised draft - submitted to EPA).
http://www.deq.state.id.us/water/data_reports/surface_water/tmdls/american_falls/american_falls.cfm
- IDHW. 2002. Health effects of EDB in your drinking water: Fort Hall Indian Reservation and north Bannock County, Idaho. Idaho Department of Health and Welfare, Bureau of Community and Environmental Health.
- IDWR Statewide Ambient Ground Water Quality Monitoring Program, Online database. Accessed July 2006. <http://www.idwr.idaho.gov/gisdata/mapserver.htm>
- ISCC. 2003. Portneuf River TMDL Agricultural Implementation Plan.
http://www.deq.state.id.us/water/data_reports/surface_water/tmdls/portneuf_river/portneuf_river_implementation_plan_sec6.pdf
- Ley, TW, RG Stevens, RR Topielec, and WH Neibling. Soil water monitoring and measurement. Pacific Northwest Publication No. 475.
<http://cru.cahe.wsu.edu/CEPublications/pnw0475/pnw0475.html#anchor775570>
- Lin, C. 2006. Summary of year 2004 detections of concern, Statewide Ambient Ground Water Quality Monitoring Program. Idaho Department of Water Resources.
http://www.idwr.idaho.gov/hydrologic/info/pubs/gwq/Detections_of_Concern_2004_Final.pdf
- Mansfield, G.R. 1920. Geography, geology, and mineral resources of the Fort Hall Indian Reservation, Idaho. US Geological Survey Bulletin 713.
- Miller, J. 2002. Green manure demonstration project in Idaho. Journal of Pesticide Reform 22-4:10.
- Neely, KW. 2002. Nitrate results from the Statewide Program, 1991-2000. Idaho Department of Water Resources. (http://www.idwr.state.id.us/hydrologic/info/pubs/trs/trs-nitrate_1991-2000.pdf).
- Neely, KW, and JK Crockett. 1999. Nitrate in Idaho's ground water. Idaho Department of Water Resources, Technical Results Summary 1.

- Neely, KW. 2005. Nitrate Overview for the Statewide Ambient Ground Water Quality Monitoring Program, 1990 – 2003.
http://www.idwr.idaho.gov/hydrologic/info/pubs/gwq/Nitrate_Report_2005.pdf
- Orloff, S, B Hanson, and D. Putnam. 2003. Utilizing Soil-Moisture Monitoring to Improve Alfalfa and Pasture Irrigation Management. Plant Management Network.
<http://www.plantmanagementnetwork.org/pub/cm/management/2003/moisture/>
- Parlman, DJ. 2002. Analysis of nitrate (NO₃-N) concentration trends in 25 Ground Water Quality Management Areas, Idaho, 1961- 2001. USGS, Water Resource Investigations Report WRIR 02-4056 (<http://idaho.usgs.gov/PDF/wri024056/index.html>).
- Parlman, D.J. 2001. Soil analyses for 1,3-dichloropropene (1,3-DCP), sodium N-methyldithiocarbamate (meatm-sodium), and their degradation products near Fort Hall, Idaho, September 1999 through March 2000. USGS Water Resources Investigation Report 01-4052.
- Parlman, D.J., and H.W. Young. 1988. Selected water-quality data for the Fort Hall Indian Reservation , Southeastern Idaho, July 1988. USDI-USGS Open File Report 88-496.
- Parlman, D.J., and H.W. Young. 1989. Selected ground-water quality data for the area near Fort Hall, Fort Hall Indian Reservation , Southeastern Idaho, June 1989. USDI-USGS Open File Report 89-594.
- Parlman, D.J., and H.W. Young. 1992. Water levels in selected wells and directions of ground water movement near Fort Hall, Fort Hall Indian Reservation, southeastern Idaho. U.S. Geological Survey Water Resources Investigations Report 92-4014.
- Robbins, C. W., and D. L. Carter. 1980. Nitrate-Nitrogen Leached Below the Root Zone During and Following Alfalfa. *J. Environ. Qual.* 9(3):447-450, Jul-Sep 1980. *Rupert, MG. 1996. Major sources of nitrogen input and loss in the upper Snake River basin, Idaho and western Wyoming, 1990. USGS Water Resources Investigations Report 96-4008.*
- Rupert, MG. 1996. Major sources of nitrogen input and loss in the upper Snake River basin, Idaho and western Wyoming, 1990. USGS Water Resources Investigations Report 96-4008.
- Rupert, MG. 1998. Probability of Detecting Atrazine/Desethyl-Atrazine and Elevated Concentrations of Nitrate (NO₂+ NO₃- N) in Ground Water in the Idaho Part of the Upper Snake River Basin. USGS, Water Resources Investigations Report 98-4203.
- Safford, L. 2005. Update on ethylene dibromide contamination in north Bannock and eastern Bannock Counties, Idaho. Idaho Department of Environmental Quality, Pocatello.
- Shock, C.C., Flock, R., Feibert, E., Shock, C.A., Pereira, A. and Jensen, L. 2005. Irrigation monitoring using soil water tension. Oregon State University Extension, EM 8900.
- Stark, J.C., 1993. Progress Report, Irrigation and Nutrient Management of Maximum Potato Production Efficiency. Project No. 061-K264,

- Taberna, J. Jr. 1993. Pollution Prevention Project. Fort Hall Indian Reservation. Shoshone-Bannock Tribes in cooperation with NRCS.
- Thomson, SJ and Ross, BB. 1996. Using soil moisture sensors for making irrigation management decisions in Virginia. Virginia Tech Extension, Publication Number 442-024. <http://www.ext.vt.edu/pubs/rowcrop/442-024/442-024.html>
- Three Rivers RC&D, 2004. Fort Hall Indian Reservation Demonstration Project – Project Summary. Three Rivers Resource Conservation and Development, Pocatello, Idaho. <http://www.3riversrcd.org/images/documents/Fort%20Hall%20Demo%20Summary%20for%20web.pdf>
- USDA-NRCS. 1991. Preliminary Investigation Report, Fort Hall Ground Water Quality Project, Bingham County, Idaho, May 1991. SCS for Shoshone-Bannock Tribes
- USDA-SCS. 1977. Soil Survey of Fort Hall Area, Idaho (Parts of Bannock, Bingham, Caribou, and Power Counties).
- USHHS. 2005. Health consultation. Evaluation of organic contaminants in the private wells located off the Fort Hall Indian Reservation site, Bannock County, Idaho. US Department of Health and Human Services, Public Health Services.
- Van Steeter, MM, RL Mahler, and LL Mink. 1998. Ground water in Idaho. University of Idaho Cooperative Extension System, Water Quality for Idaho Current Information Series No. 900. (<http://www.uidaho.edu/wq/wqpubs/cis900.html>).
- Western-SARE. 2003. Project Report, Annual Results. Exploration and implementation of sustainable agricultural practices and outreach on the Fort Hall Indian Reservation for the protection of ground water. Western Region Sustainable Research and Education.
- Young, HW, and DJ Parlman. 1988. Selected water-quality data for the Fort Hall Indian Reservation , Southeastern Idaho, July 1988. USDI-USGS Open File Report 88-496.

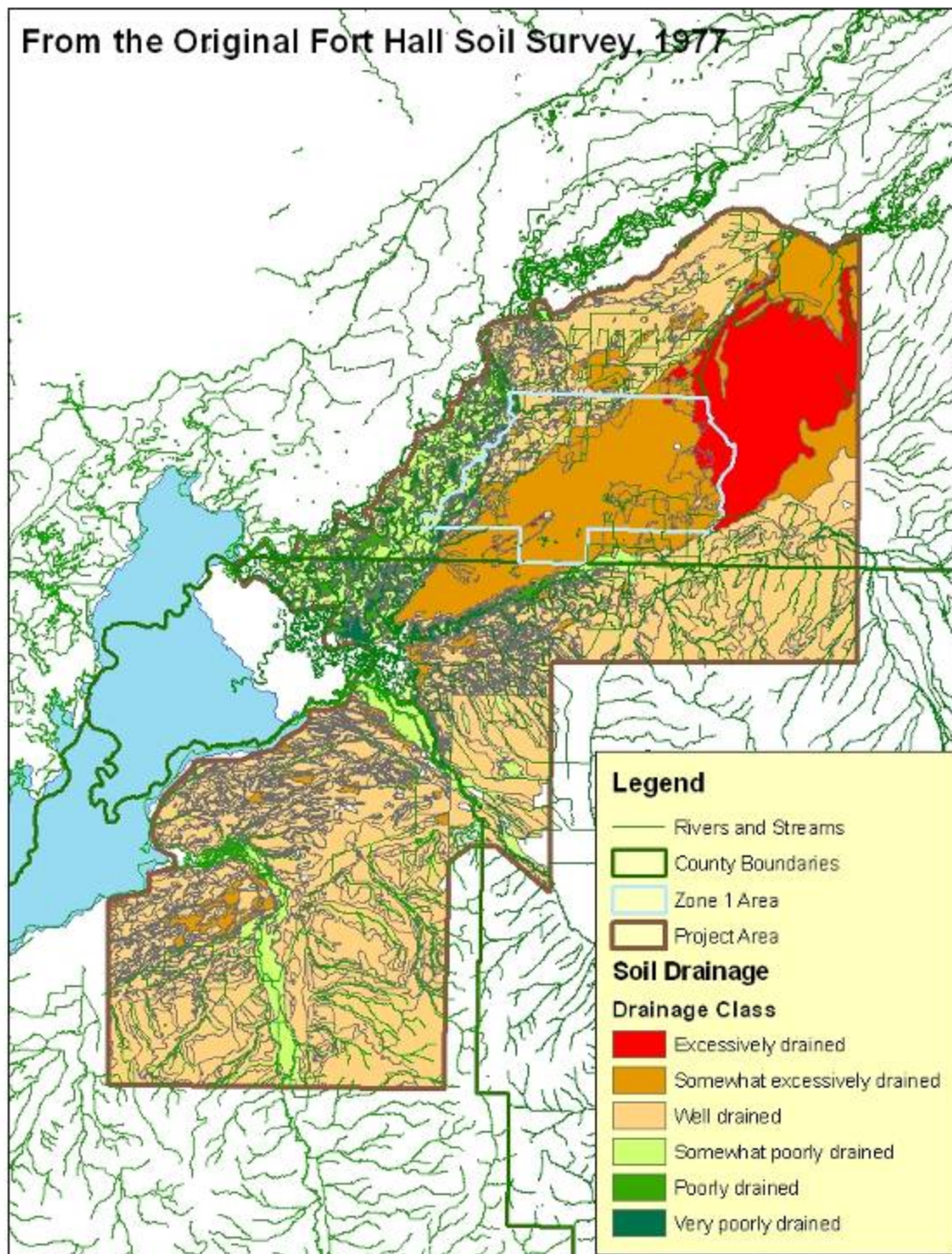
APPENDIX A. WATERSHED MAPS

PAGE LEFT INTENTIONALLY BLANK



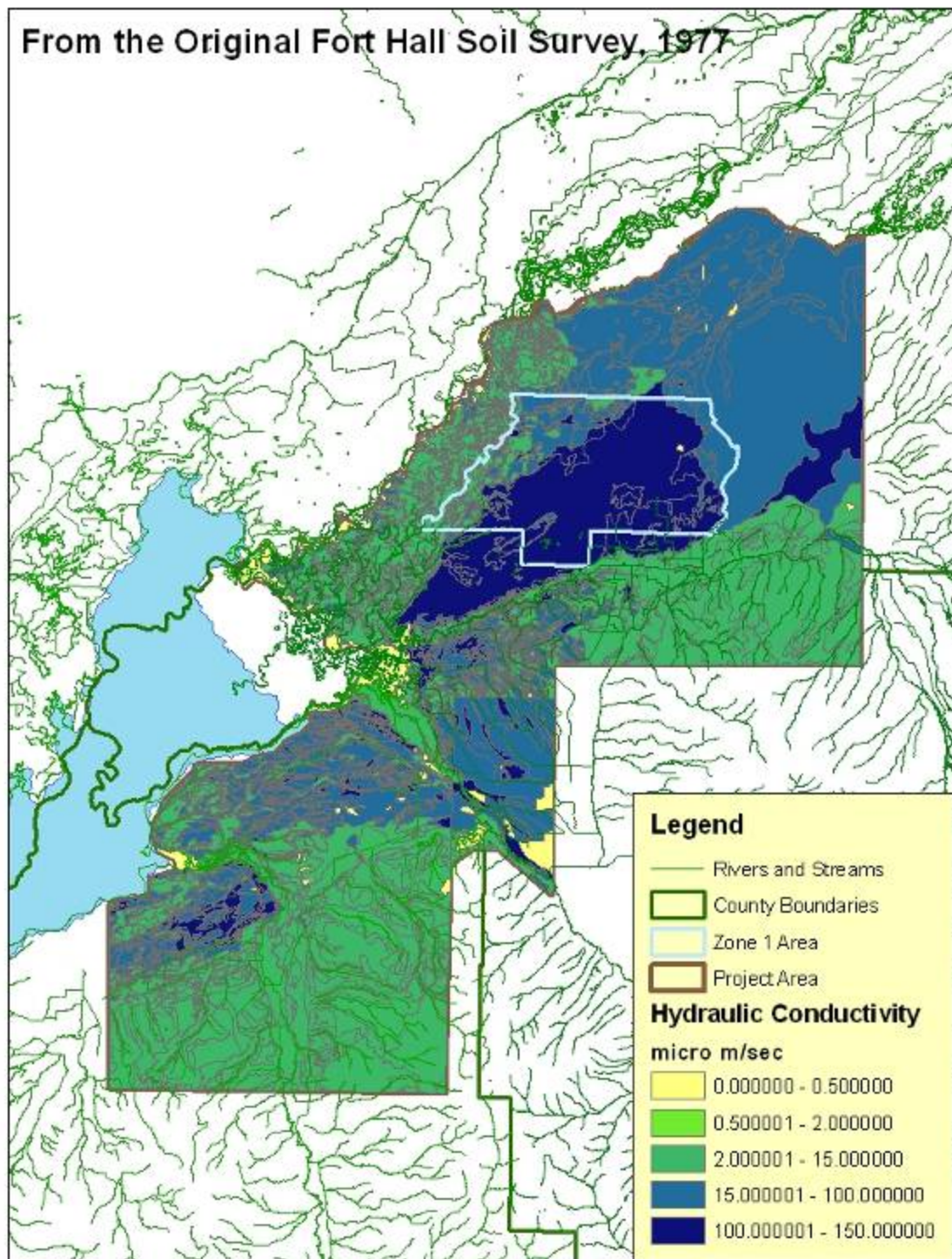
Map 1. Land use and land cover with the project area.

PAGE LEFT INTENTIONALLY BLANK



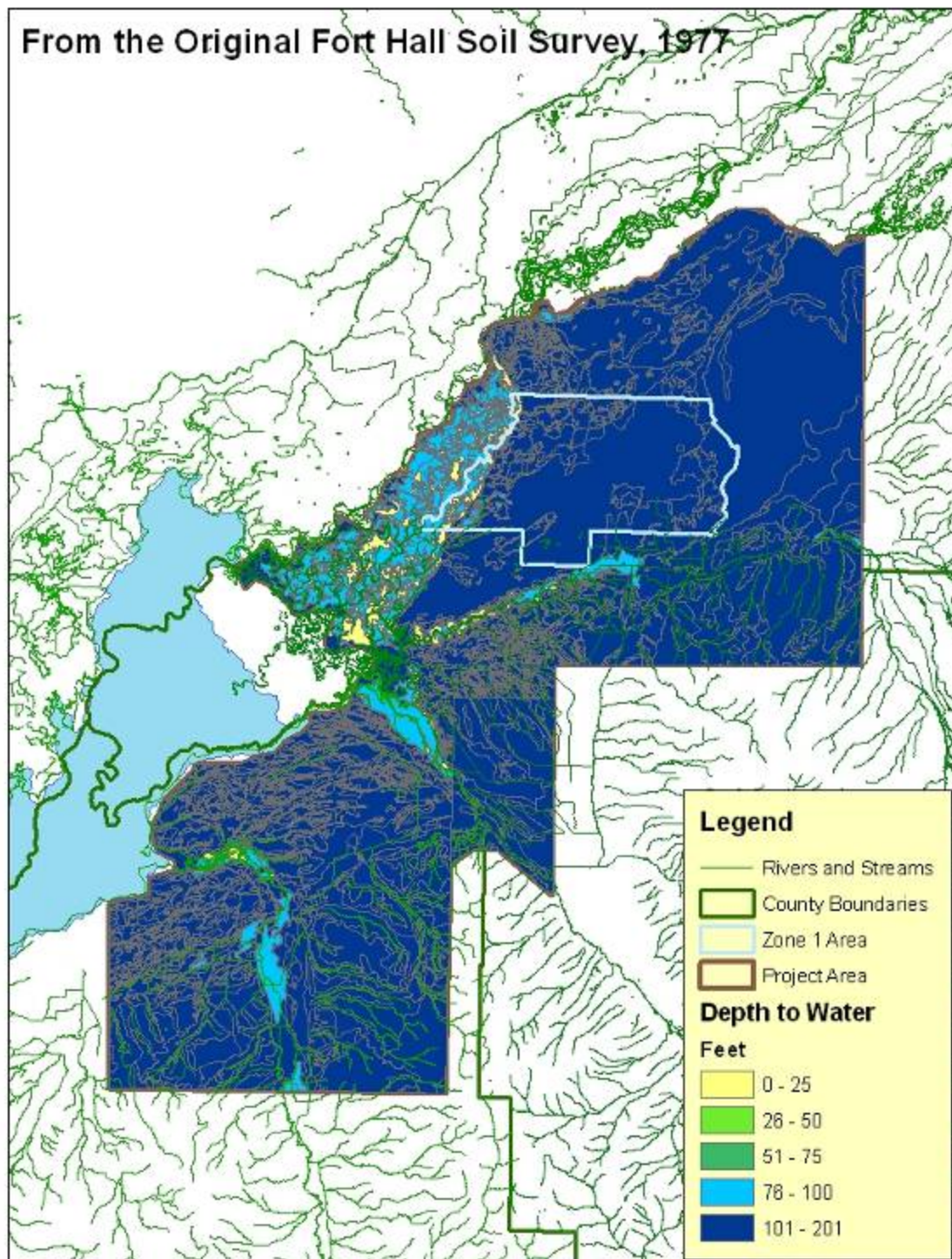
Map 2. Soil drainage classes within the project area based on the 1977 soil survey.

PAGE LEFT INTENTIONALLY BLANK



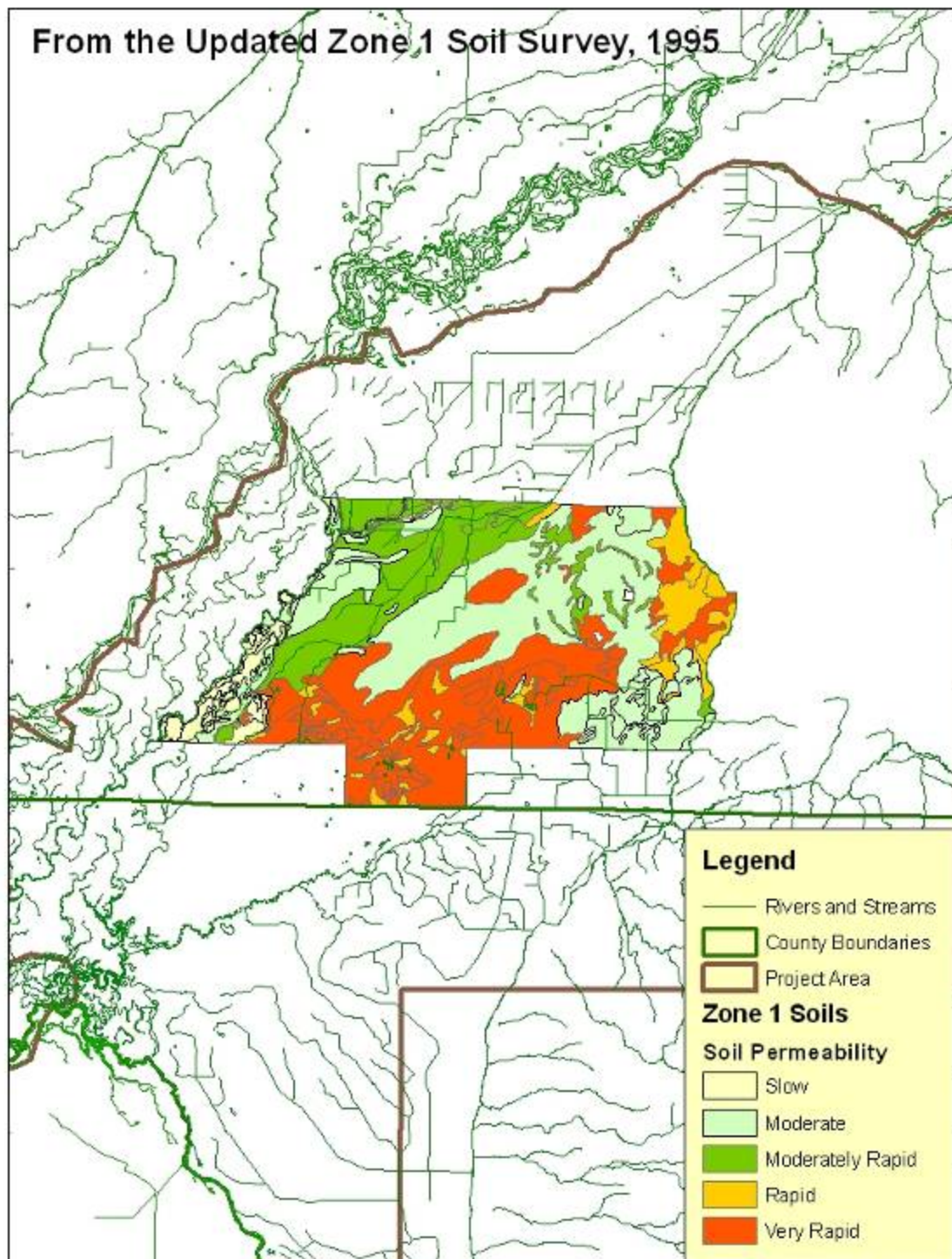
Map 3. Soil hydraulic conductivity class within the project area based on the 1977 soil survey.

PAGE LEFT INTENTIONALLY BLANK



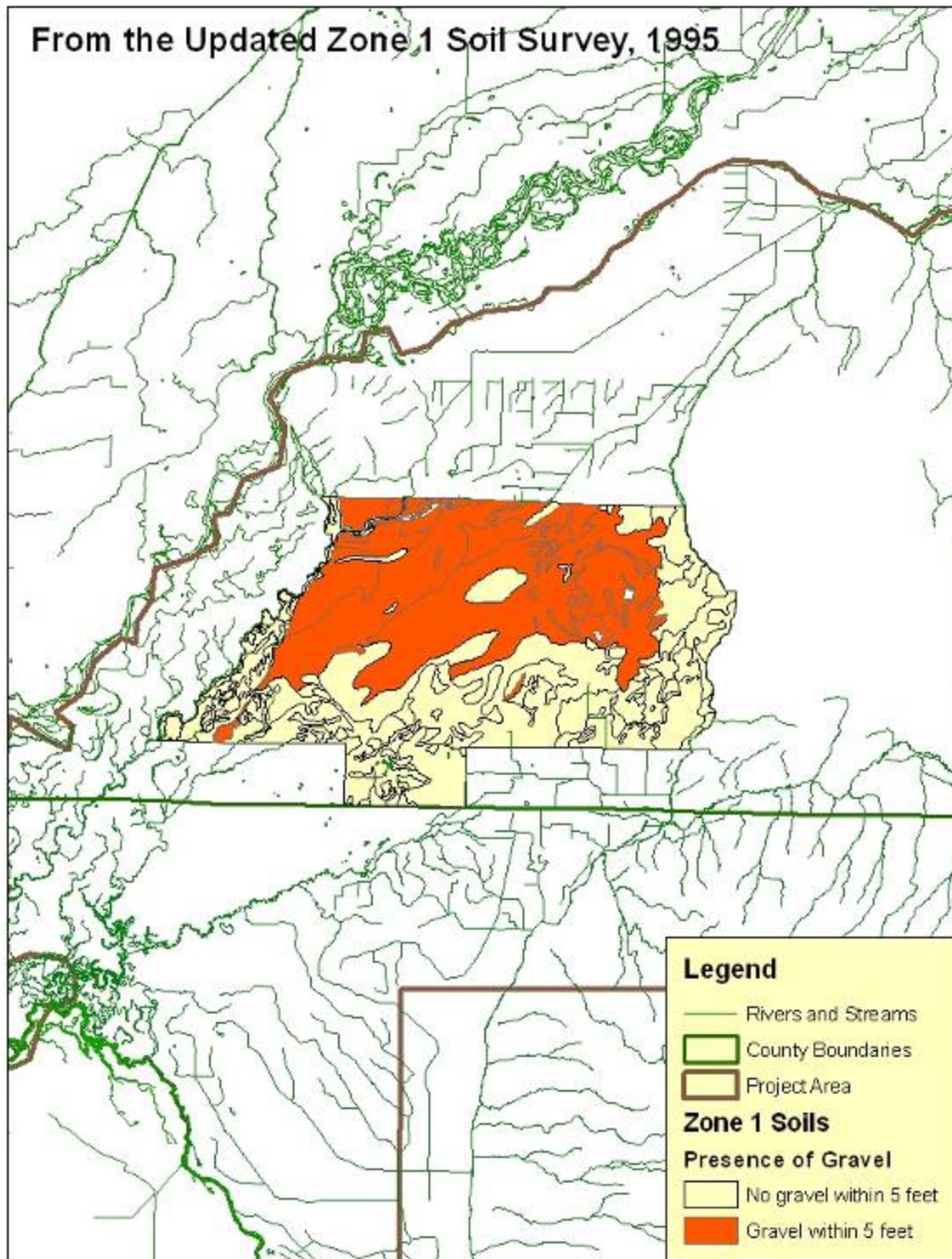
Map 4. Depth to water with the project area based on the 1977 soil survey.

PAGE LEFT INTENTIONALLY BLANK



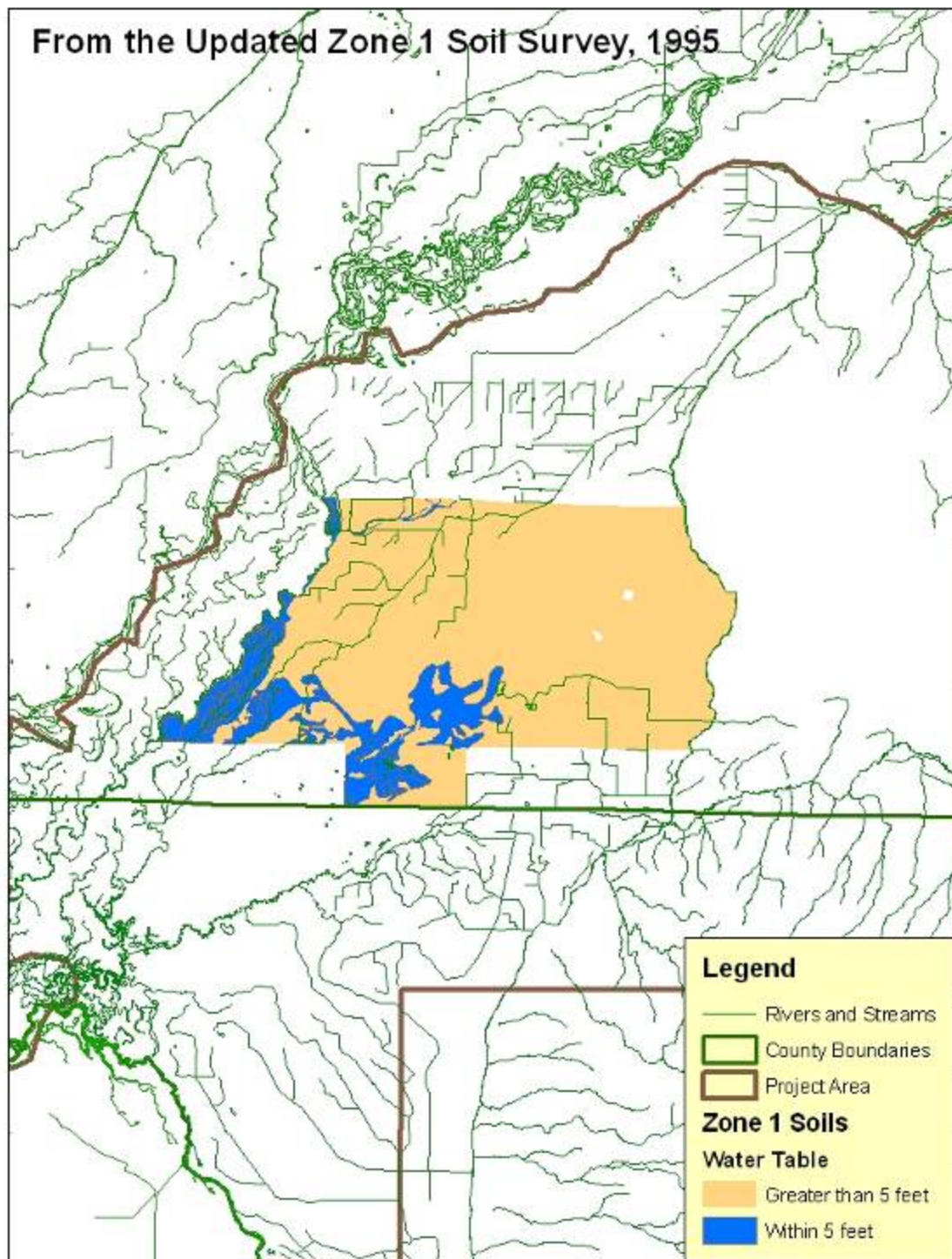
Map 5. Soil permeability ratings for Zone 1 soils based on the 1995 soil survey.

PAGE LEFT INTENTIONALLY BLANK



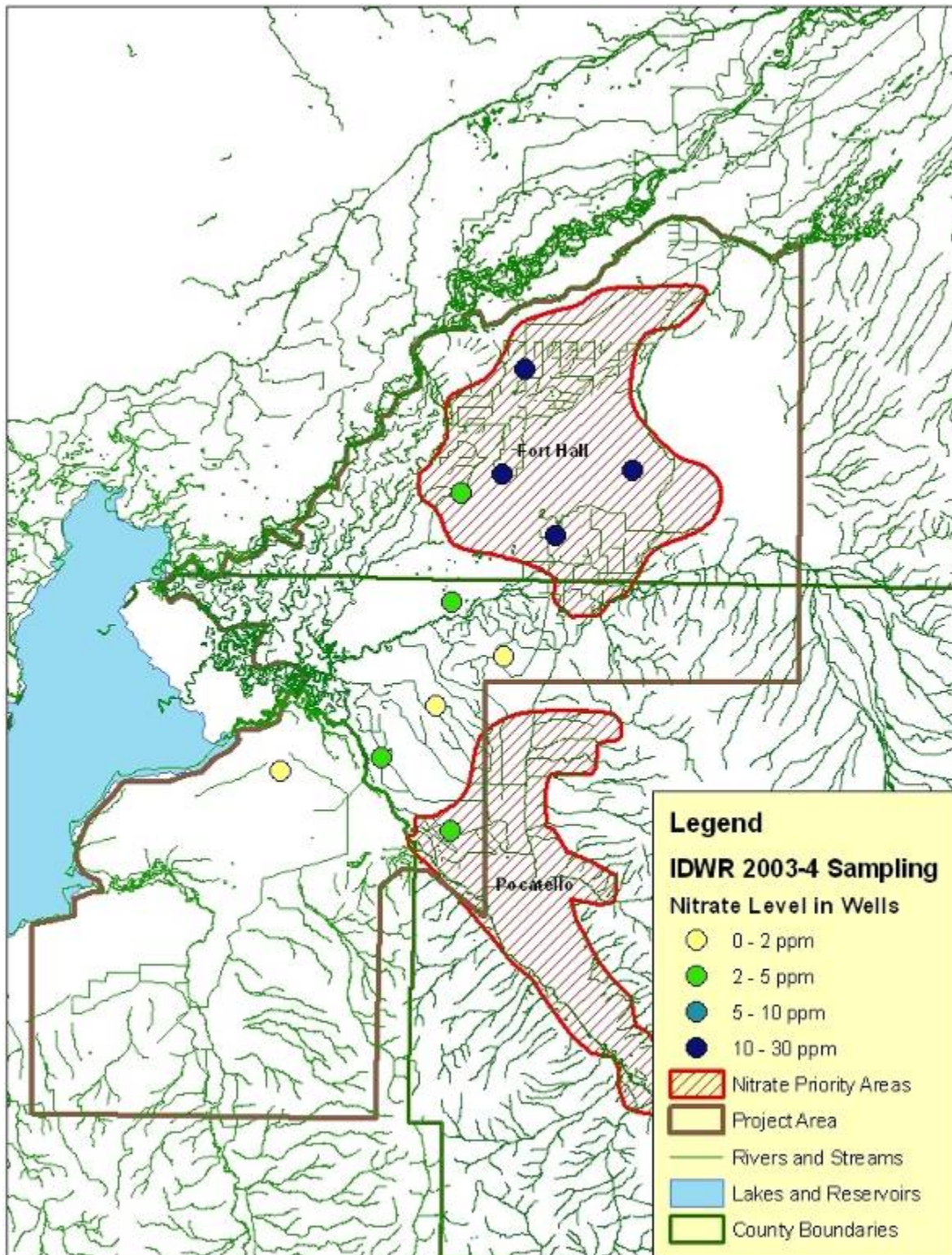
Map 6. Presence of gravel in soils within Zone 1 based on the 1995 soil survey.

PAGE LEFT INTENTIONALLY BLANK



Map 7. Depth to water table (including seasonal) within Zone 1 based on the 1995 soil survey.

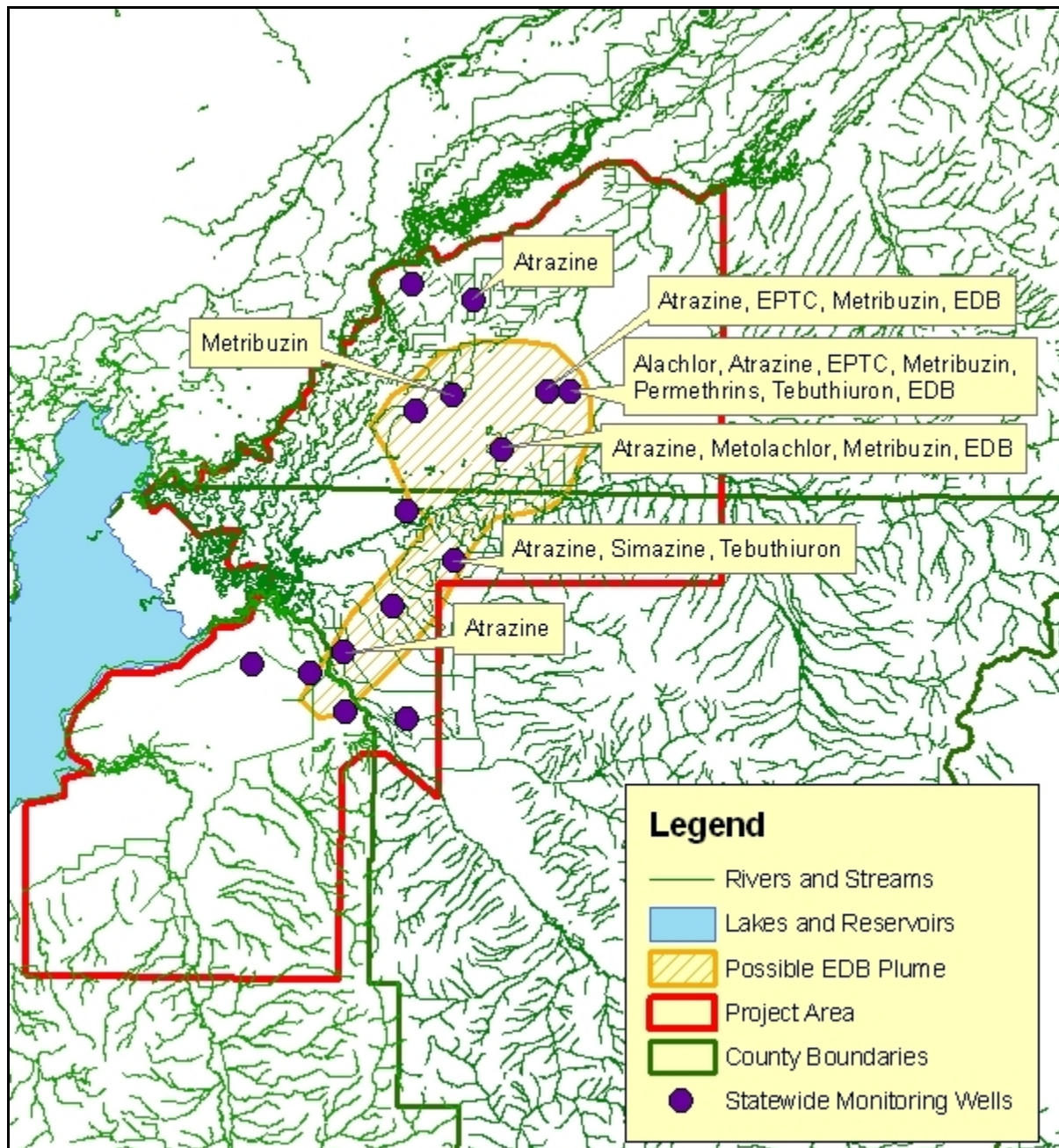
PAGE LEFT INTENTIONALLY BLANK



Map 8. Nitrate levels in wells in the project area sampled during 2003-4.

Sampled for the IDWR Statewide Monitoring Program -- location of the nitrate priority areas also shown.

PAGE LEFT INTENTIONALLY BLANK



Map 9. Location of wells within the project area with recent pesticide detections.
Areas identified where EDB has been detected or is a possible concern.

PAGE LEFT INTENTIONALLY BLANK

PAGE LEFT INTENTIONALLY BLANK